

## CONTENTS

Testing and repair: W-001/507  
Product IE starting motor

Part no. 0 001 370 ...  
0 001 371 ...

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Continue: I01/2

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Starting-motor assembly	III16/1

Continue: I02/1

## SPECIAL FEATURES

These instructions describe repairs to type IE sliding-gear starting motors

0 001 370 ... 12 V/5.0 kW  
0 001 371 ... 24 V/6.7 kW

Always use Loctite 5 965 930 512 on assembly to secure bearing pin of engaging lever in drive-end bearing.

Continue: I02/2

## SPECIAL FEATURES

Renew needle bushings in drive-end and intermediate bearing.

All gaskets and seals are likewise to be renewed.

There is no test method for the solenoid switch which provides reliable information on trouble-free operation over a lengthy period. It is therefore advisable to renew the solenoid switch as well when repairing the starting motor.

Continue: I03/1

## SPECIAL FEATURES

Prior to assembly, apply a small quantity of special grease 5 932 240 150 to the O-rings.

Continue: I01/1

## STRUCTURE, USAGE

User prompting is provided on every page e.g.:

- Continue: I 17/1
- Continue: II 18/1      Fig.: II 17/2

Brief instructions may include several rows of coordinates.

I../. = first coordinate row  
II../. = second coordinate row  
III../. = third coordinate row  
etc.

.../1 = upper coordinate half  
.../2 = lower coordinate half

Continue: I01/1

## GENERAL

Unless otherwise stated, the voltage values given in these instructions are AC values. The symbol "=" is used to indicate DC voltage.

Continue: I05/2

## GENERAL

Expert repairs can only be performed with the prescribed tools and properly functioning measuring instruments. We therefore recommend that exclusive use be made of the tools indicated.

The use of incorrect and unsuitable tools and testers may result in injury and could cause damage to the product and components.

Continue: I06/1

## GENERAL

Make exclusive use of service parts as per the replacement parts list for the type of starting motor concerned.

To guarantee proper functioning, use must be made of the lubricants prescribed in these instructions before and during assembly.

Take care to ensure cleanliness when performing repair work.

Continue: I01/1

## **SAFETY MEASURES**

### **Component cleaning:**

Armature, excitation winding, relay and overrunning-clutch drive are only to be cleaned with compressed air (max. 4 bar) and a clean rag. Never use liquid cleaning agent.

Other parts such as intermediate and drive-end bearing can be washed out in commercially available cleaning agent which is not readily flammable. Take care not to inhale vapors.

**Continue: I07/2**

## **SAFETY PRECAUTIONS**

**Danger of fire: Avoid naked flames, light and sparks.**

### **ATTENTION:**

Thoroughly dry cleaned components, as gases may subsequently form in the sealed starting motor and cause an explosion.

Always use tools indicated. The use of incorrect and unsuitable tools and testers could lead to injury.

**Continue: I08/1**

## SAFETY PRECAUTIONS

Pay attention to the following safety regulations:

- \* Order governing work with flammable liquids (VbF) as issued by the German Ministry of Labor (BmA).
  - \* Accident prevention regulations for electrical systems and equipment.
  - \* Safety regulations for handling chlorinated hydrocarbons:
    - For companies: ZH 1/222
    - For employees: ZH 1/129
- as issued by the Main Association for Professional Liability Insurance Associations (Central Association for Accident Prevention and Industrial Medicine), Langwartweg 103, 53129 Bonn.

Continue: I08/2

## SAFETY PRECAUTIONS

Outside Germany, pay attention to the appropriate local regulations.

Skin protection:

To prevent skin irritation when working with oil and grease, apply hand cream before starting work and wash hands in soap and water afterwards.

Continue: I01/1



## TESTERS, FIXTURES, TOOLS

The following list indicates all the tools required for repairing type IE starting motors.

Some of the tools needed must be user-manufactured in line with drawings.

If tools used to be ordered on the basis of type designation, this is indicated in parentheses.

Continue: I09/2

## TESTERS, FIXTURES, TOOLS

Interturn-short-circuit tester  
with test prods: 0 986 619 110

Test prods: 0 986 619 101  
(old version: 0 986 619 114)

Alternator tester  
WPG 012.00: 0 684 201 200  
(optionally Motortester)

Magnetic instru-  
ment stand: 4 851 601 124

Dial indicator: 1 687 233 011

Mandrel press: comm. avail.

Continue: I10/1

TESTERS, FIXTURES, TOOLS

Clamping support:	0 986 619 362 (KDAW 9999)
Claw-type puller:	comm. avail.
Depth gauge:	comm. avail.
Torque wrench (0...70 Nm):	comm. avail.
Torquemeter (0.15...0.80 Nm):	0 986 617 206 (KDAL 5485)
Spring balance (0...160 N):	comm. avail.

Continue: I10/2

TESTERS, FIXTURES, TOOLS

Spring balance (2...12 N):	0 986 619 181 (KDAW 9991)
Pole-shoe screwdriver:	0 986 619 393 (KDAW 9999/7)
Torx T50 bit socket with hexagon 5/16":	comm. avail.
Torx T40 bit socket with hexagon 1/4":	comm. avail.
Torx T30 bit socket with hexagon 1/4":	comm. avail.

Continue: I11/1

TESTERS, FIXTURES, TOOLS

Pressing-out mandrel for  
needle bushing in  
intermediate bearing: 0 986 617 129  
(KDAL 5039)

Pressing-in mandrel for  
needle bushing in  
intermediate bearing: 0 986 617 130  
(KDAL 5040)

Pressing-in mandrel for  
radial-lip-type oil seal  
in intermediate bearing: 0 986 617 144  
(KDAL 5053)

Assembly tool for  
brush holder plate: 0 986 617 145  
(KDAL 5054)

Continue: I11/2

TESTERS, FIXTURES, TOOLS

Tailstock chuck with  
Morse taper 2 for clamping  
diameter 5...45 mm  
for holding armature when  
turning down: 0 986 619 156  
(KDAW 9987)

Driving-in mandrel  
diameter: 75,85 - 0,05 mm  
(user-manufacture)

Continue: I12/1

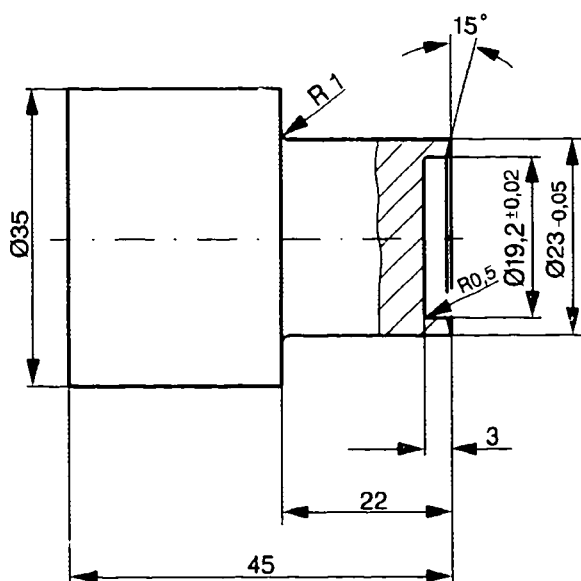
# TESTERS, FIXTURES, TOOLS

Pressing-out/pressing-in  
mandrel for needle  
bushing in

drive-end bearing: user-manufacture

Continue: I01/1 Fig.: I12/2

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## TEST SPECIFICATIONS AND SETTINGS

Min. commutator dia.:	42,5 mm
Radial runout	
- Commutator:	0,03 mm
- Laminated core:	0,08 mm
Carbon brush as-new size:	17,5 mm
Carbon brush min. size:	9,5 mm
Brush pressure with new carbon brushes:	47...53 N
Armature axial clearance:	0,1...0,3 mm

Continue: I13/2

## TEST SPECIFICATIONS AND SETTINGS

Armature braking torque:	0,8... 1,2 Nm
Pinion rest pos. a:	47 ...49 mm
Tot. pinion travel b:	68,2... 70,8 mm
Pinion displacement:	10 ... 11,4 mm
Installation dimension a of needle bushing in drive-end bearing:	146,8...147,2 mm

Continue: I14/1

# TEST SPECIFICATIONS AND SETTINGS

## Shunt field resistance

12 V starting

motor: 0,38 ...0,42 Ohm

24 V starting

motor: 1,60 ...1,76 Ohm

## Resistances

Solenoid switch - 12 V

Pull-in winding: 0,175...0,185 Ohm

Holding winding: 0,421...0,443 Ohm

Solenoid switch - 24 V

Pull-in winding: 0,524...0,552 Ohm

Holding winding: 1,6 ...1,7 Ohm

Continue: I01/1

## TIGHTENING TORQUES

Bearing end plate attachment to commutator end shield:	4...5	Nm
Attachment of commutator end shield and drive-end bearing:	9,8...12,2	Nm
Relay attachment:	7,6... 8,4	Nm
Bearing pin of engaging lever in drive-end bearing (hexagon nut):	9...11	Nm
Pole-shoe screws:	40...53	Nm
Stranded wires, carbon brushes:	3... 4	Nm
Terminal screw, excitation winding:	15...17	Nm

Continue: I15/2

## TIGHTENING TORQUES

Attachment of busbar to terminal screw of excitation winding:	15...17	Nm
Attachment of busbar to solenoid switch:	16...20	Nm
Terminal stud, ground connection (insulated design only):	17...19	Nm
Connection, ground cable (insulated design only):	15...17	Nm

Continue: I01/1

# LUBRICANTS/LUBRICATION SCHEDULE

## General:

Always keep commutator and carbon brushes free from grease and oil.

Greased parts are to be degreased before being relubricated.

Slightly lubricate bright parts (bolts, nuts, fits etc.).

Oil 41 v 2:

5 701 351 000

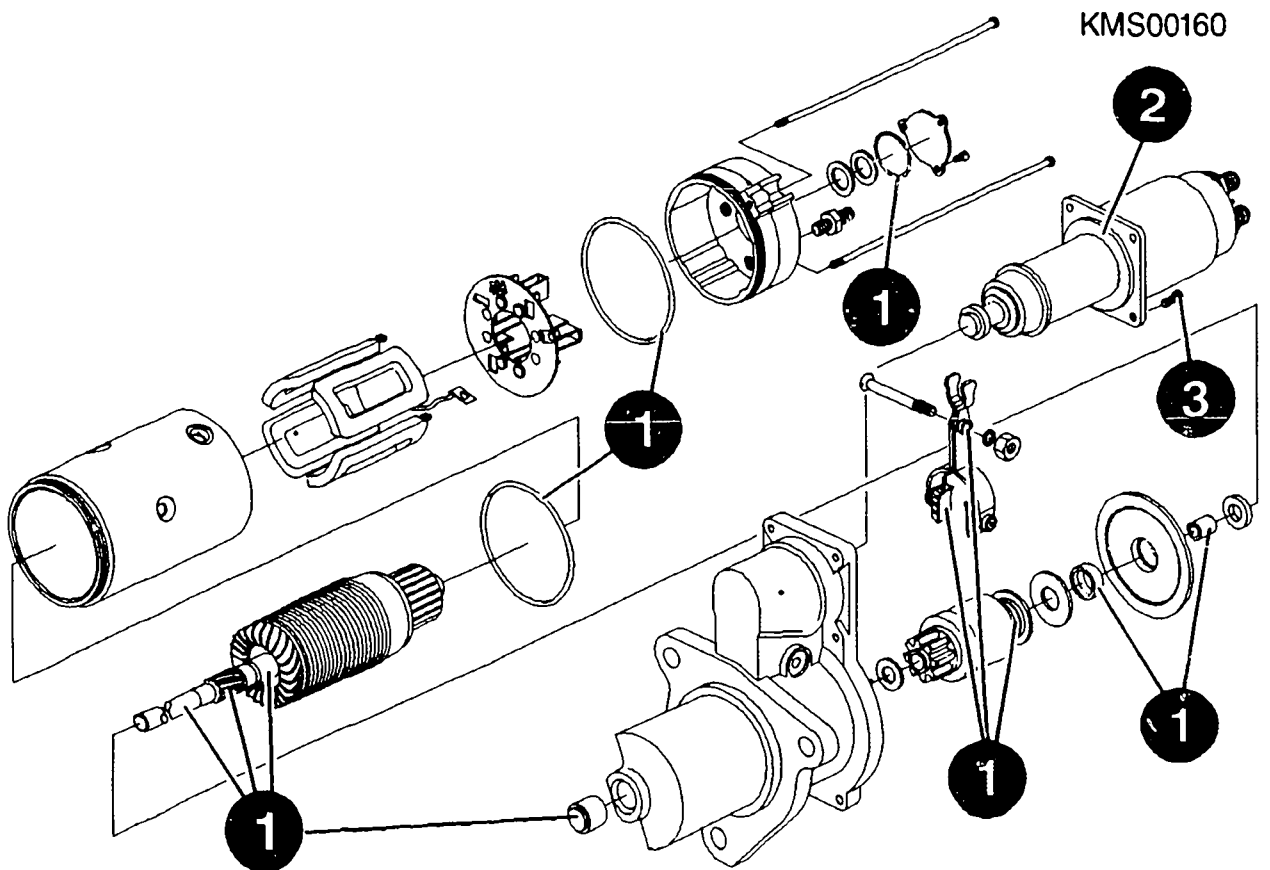
Continue: I17/1



# LUBRICANTS/LUBRICATION SCHEDULE

1	=	Grease VS 10832 Ft 5 932 240 000
2	=	Grease VS 16634 Ft 5 990 260 000
3	=	Loctite for securing screws VS 14618 Kk
		5 965 930 512

Continue: I01/1 Fig.: I17/2



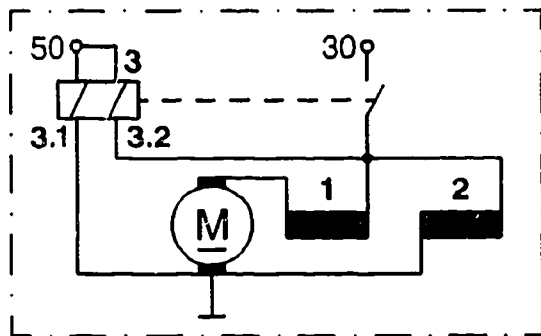
# CIRCUIT DIAGRAM

Standard version

- 1 = Series winding
- 2 = Shunt winding
- 3 = Solenoid switch
- 3.1 = Holding winding
- 3.2 = Pull-in winding

Continue: I19/1 Fig.: I18/2

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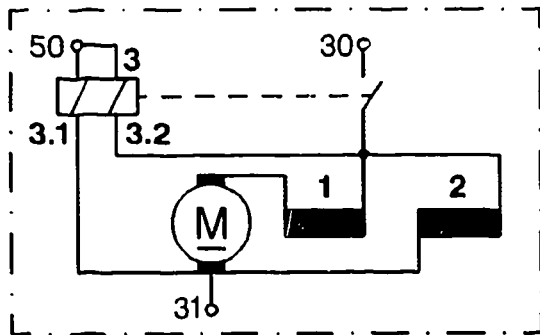
# CIRCUIT DIAGRAM

## Insulated design

- 1 = Series winding
- 2 = Shunt winding
- 3 = Solenoid switch
- 3.1 = Holding winding
- 3.2 = Pull-in winding

Continue: I01/1 Fig.: I19/2

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# STARTING-MOTOR DISASSEMBLY TABLE

Solenoid switch disassembly	I21/1
Bearing end plate disassembly	I24/1
Commutator end shield disassembly	I25/1
Brush holder plate disassembly	I26/1
Carbon brush disassembly	I27/1
Drive end bearing disassembly	I28/1
Gear unit disassembly	II02/1
Intermediate bearing disassy.	II03/1
Armature disassembly	II04/1

Continue: I01/1

# STARTING MOTOR DISASSEMBLY

Solenoid switch disassembly

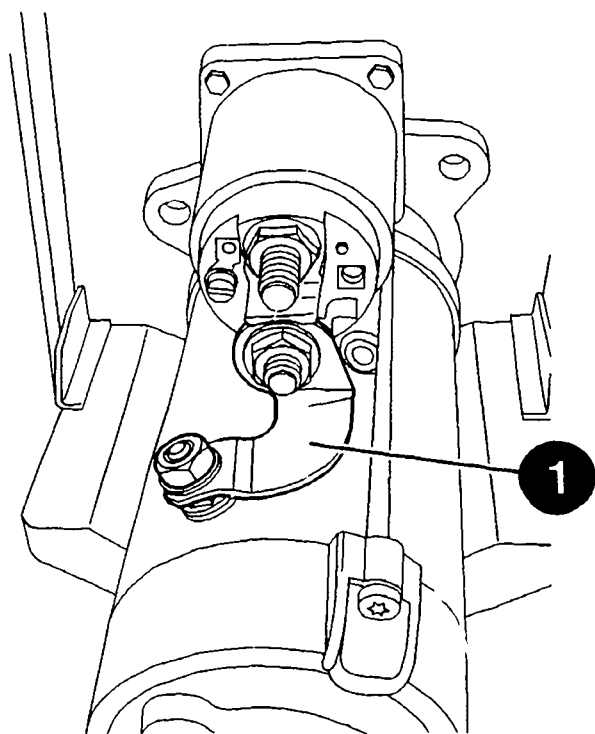
Clamp starting motor in clamping support.

Remove busbar (1).

Clamping support: 0 986 619 362

Continue: I22/1 Fig.: I21/2

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## STARTING MOTOR DISASSEMBLY

### Solenoid switch disassembly

Mark position of solenoid switch.

Unfasten switch securing bolts.

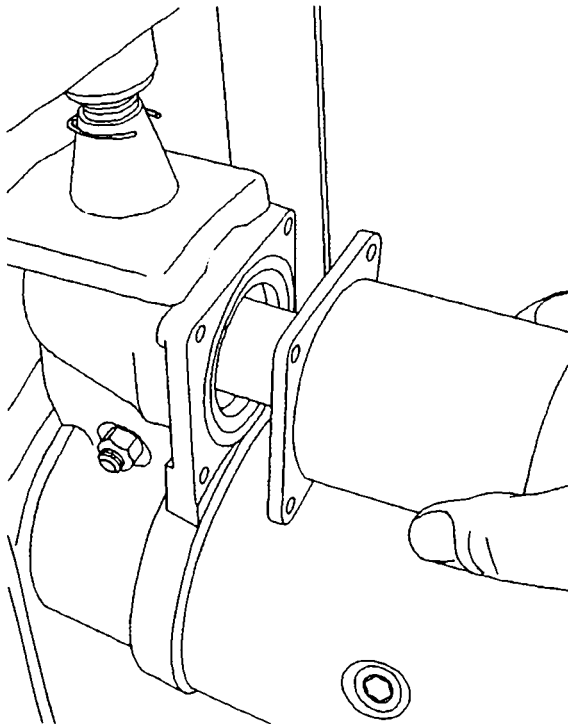
**ATTENTION: DANGER OF INJURY!**

The pretensioned return spring depresses solenoid switch off switch armature.

Pull switch off armature.

Continue: I23/1 Fig.: I22/2

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# STARTING MOTOR DISASSEMBLY

## Solenoid switch disassembly

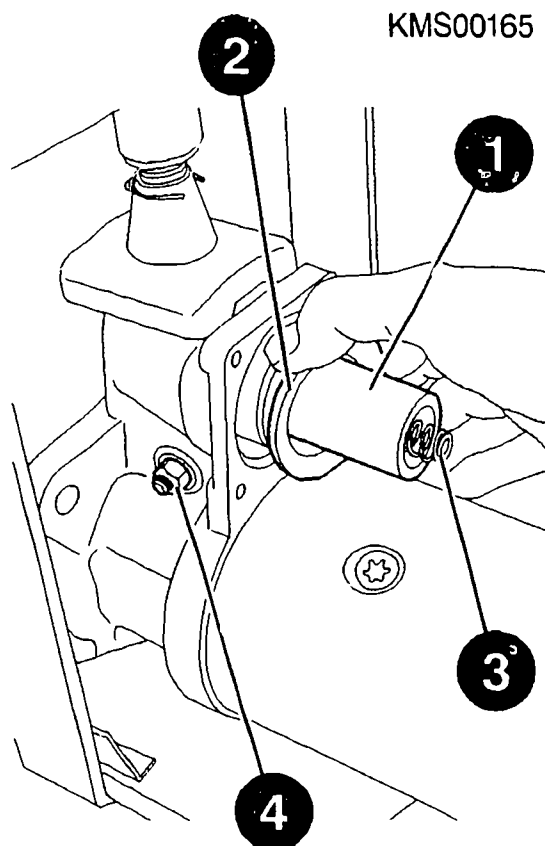
Grasp switch armature (1) at rubber bellows (2) and detach at engaging lever.

Pay attention to return spring (3) in switch armature.

Unfasten bearing pin (4) of engaging lever in drive end bearing.

Torx T40 bit socket: comm. avail.

Continue: I24/1 Fig.: I23/2



# STARTING MOTOR DISASSEMBLY

## Bearing end plate disassembly

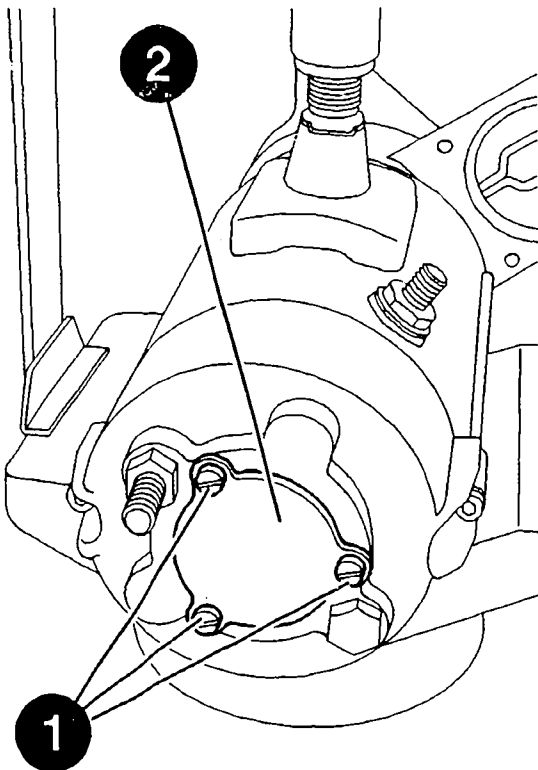
Re-clamp starting motor.

Unfasten securing bolts (1) of bearing end plate (2).

Remove bearing end plate.

Continue: I25/1 Fig.: I24/2

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# STARTING MOTOR DISASSEMBLY

## Commutator end shield disassembly

Remove shims (1) for setting armature axial clearance and O-ring (2). Mark installation position of commutator end shield and drive end bearing. Unfasten bolts (3) and remove commutator end shield (4).

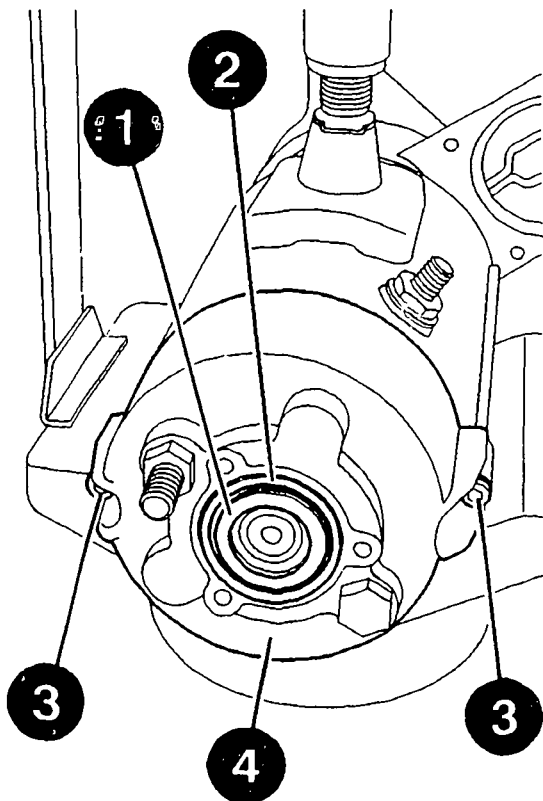
**ATTENTION: DANGER OF ACCIDENT!**

The drive end bearing is not fixed at the stator frame.

Torx T30 bit socket: comm. avail.

Continue: I26/1 Fig.: I25/2

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## STARTING MOTOR DISASSEMBLY

### Brush holder plate disassembly

Use suitable tool to raise spiral springs (1) and insert assembly tool (2) between spring and brush holder.

Unfasten connections (3) of excitation winding and carbon brushes at brush holder plate (4).

Remove brush holder plate.

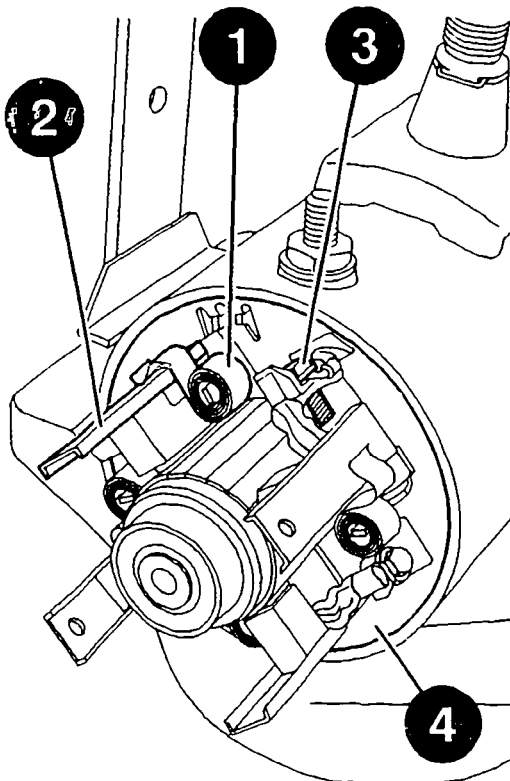
Assembly tool for

brush holder plate:

0 986 617 145

Continue: I27/1 Fig.: I26/2

KMS00168



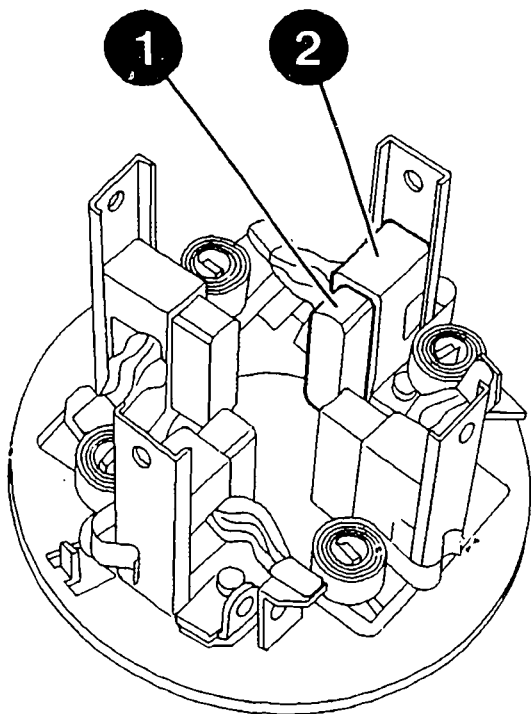
# STARTING MOTOR DISASSEMBLY

## Carbon brush disassembly

Mark installation position of carbon brushes (1).  
Remove carbon brushes from brush holders (2).

Continue: I28/1 Fig.: I27/2

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# STARTING MOTOR DISASSEMBLY

## Drive end bearing disassembly

Screw out bearing pin (1) of engaging lever in drive end bearing.

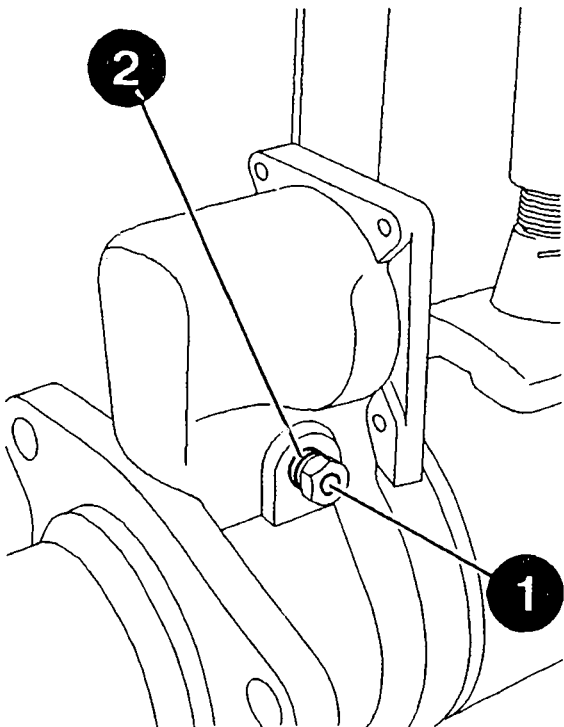
### Note:

A new copper seal (2) is to be used on assembly.

Torx T40 bit socket: comm. avail.

Continue: II01/1 Fig.: I28/2

KMS00170



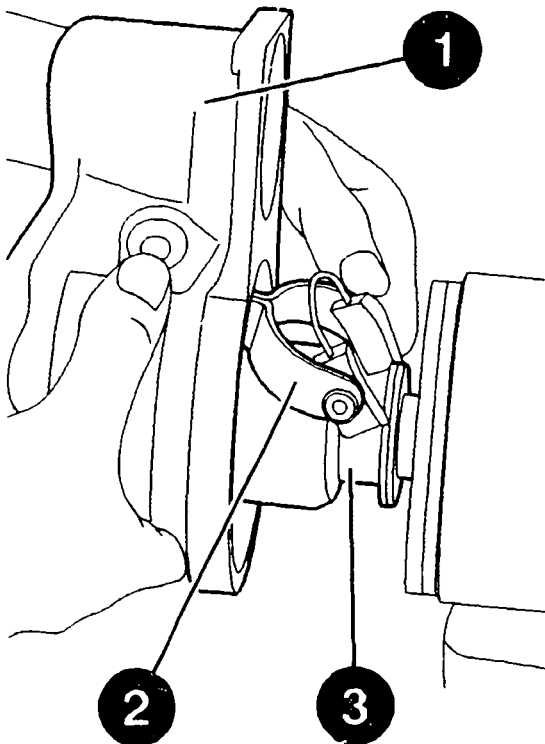
# STARTING MOTOR DISASSEMBLY

## Drive end bearing disassembly

Remove drive end bearing (1) from stator frame. In doing so, detach engaging lever (2) from driver (3) at overrunning-clutch drive.

Continue: II02/1 Fig.: II01/2

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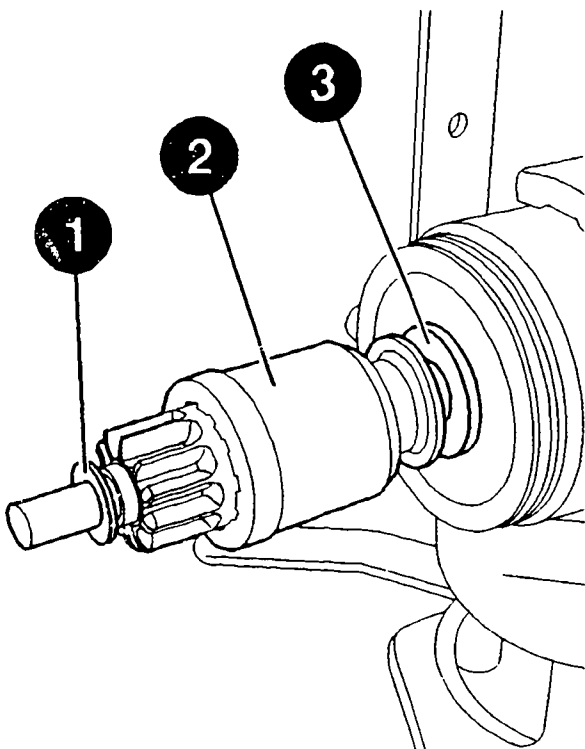
# STARTING MOTOR DISASSEMBLY

## Gear unit disassembly

Remove stop disk (1), overrunning-clutch drive with pinion (2) and brake disk (3) from armature shaft.

Continue: II03/1 Fig.: II02/2

KMS00172



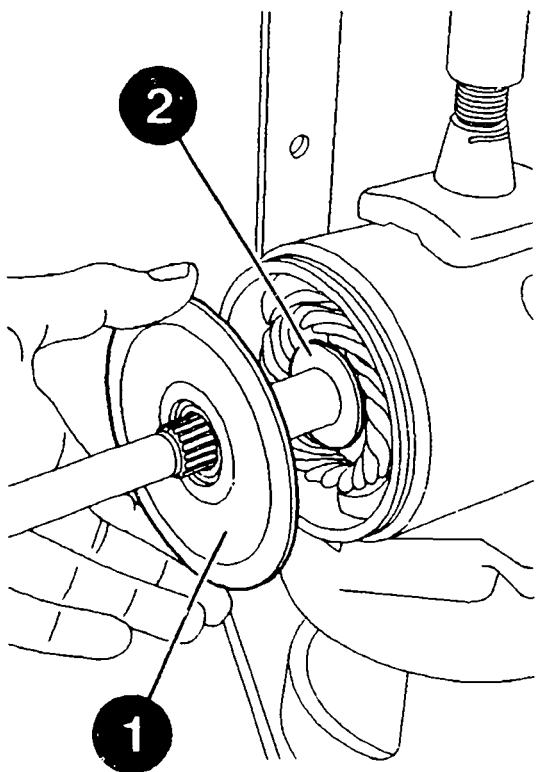
# STARTING MOTOR DISASSEMBLY

## Intermediate bearing disassembly

Remove intermediate bearing (1) and thrust washer (2) from armature shaft.

Continue: II04/1 Fig.: II03/2

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# STARTING MOTOR DISASSEMBLY

## Armature disassembly

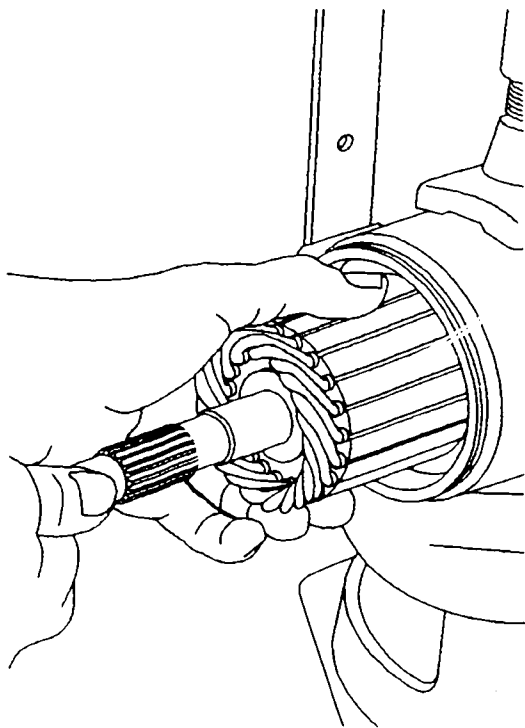
Pull armature on drive end out of stator frame.

### ATTENTION:

Take care not to damage excitation winding.

Continue: I01/1 Fig.: II04/2

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## COMPONENT CLEANING

### Component cleaning:

Armature, excitation winding, relay and overrunning-clutch drive are only to be cleaned with compressed air (max. 4 bar) and a clean rag. Never use liquid cleaning agent.

Other parts such as intermediate and drive-end bearing can be washed out in commercially available cleaning agent which is not readily flammable. Take care not to inhale vapors.

Continue: II05/2

## CLEANING OF COMPONENTS

Danger of fire: Avoid naked flames, light and sparks.

### ATTENTION:

Thoroughly dry cleaned components, as gases may subsequently form in the sealed starting motor and cause an explosion.

Continue: II06/1

## CLEANING OF COMPONENTS

Pay attention to the following safety regulations:

- \* Order governing work with flammable liquids (VbF) as issued by the German Ministry of Labor (BmA).
  - \* Accident prevention regulations for electrical systems and equipment.
  - \* Safety regulations for handling chlorinated hydrocarbons:
    - For companies: ZH 1/222
    - For employees: ZH 1/129
- as issued by the Main Association for Professional Liability Insurance Associations (Central Association for Accident Prevention and Industrial Medicine), Langwartweg 103, 53129 Bonn.

Continue: II06/2

## CLEANING OF COMPONENTS

Outside Germany, pay attention to the appropriate local regulations.

Continue: I01/1

## TESTING, REPAIR TABLE

Checking pinion	II08/1
Checking drive end bearing	II09/1
Checking commutator end shield	II12/1
Checking intermediate bearing	II14/1
Checking engaging lever	II18/1
Checking gear unit	II19/1
Checking carbon brushes	II24/1

Continue: II07/2

## TESTING, REPAIR TABLE

Checking brush holder plate	II25/1
Checking armature	II26/1
Checking commutator	III01/1
Checking excitation winding	III04/1
Replacing excitation winding	III07/1
Checking solenoid switch	III11/1

Continue: I01/1

## COMPONENT TESTING AND REPAIR

### Checking pinion

Check pinion for running marks and chipping.

If appropriate, replace pinion complete with overrunning-clutch drive.

If end face of pinion is worn, engaging lever must also be replaced in addition to overrunning-clutch drive.

Continue: II09/1

# COMPONENT TESTING AND REPAIR

## Checking drive end bearing

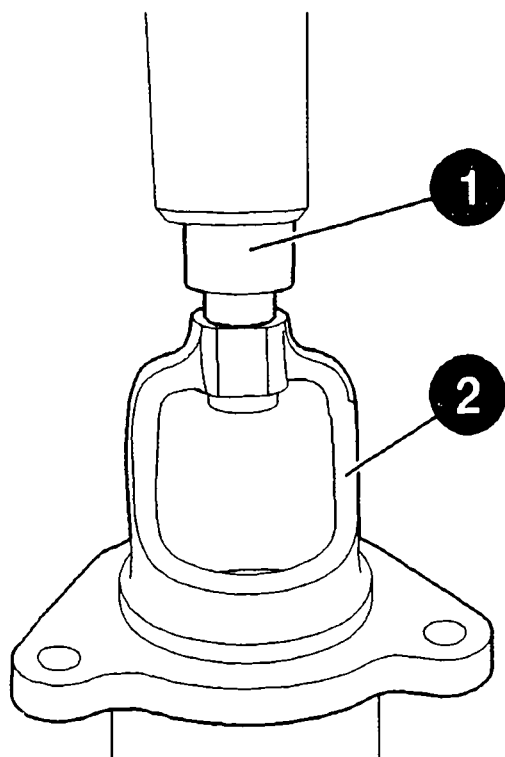
Always replace needle bushing of drive end bearing.

Removing: Use pressing-out mandrel (1) to press needle bushing out of drive end bearing (2).

Mandrel press: comm. avail.  
Pressing-out/pressing-in mandrel: user-manufacture

Continue: II10/1 Fig.: II09/2

KMS00175



# COMPONENT TESTING AND REPAIR

## Checking drive end bearing

Installing: Grease new needle bushing before pressing it in and press from outside into drive end bearing (2) using pressing-out/pressing-in mandrel (1).

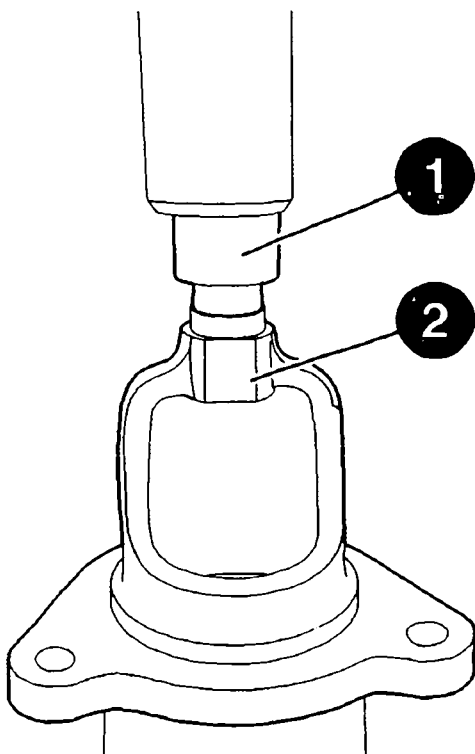
**ATTENTION:** Note installation dimension.

Mandrel press: comm. avail.  
Pressing-out/pressing  
-in mandrel: user manufacture

Grease VS 10832 Ft: 5 932 240 000

Continue: II11/1 Fig.: II10/2

KMS00176



# COMPONENT TESTING AND REPAIR

## Checking drive end bearing

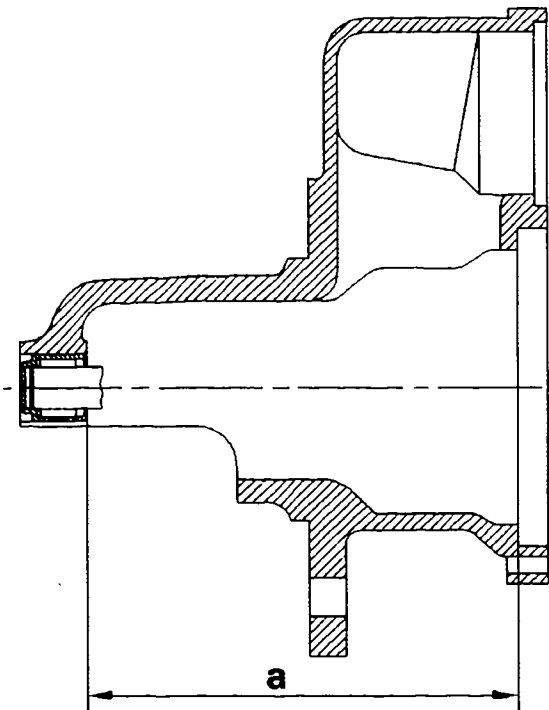
Installing: Needle bushing is to be pressed into drive end bearing so as to ensure compliance with installation dimension a between contact surface of drive end bearing and collar of needle bushing.

Depth gauge: comm. avail.

Installation dimension a: 146,8...147,2 mm

Continue: II12/1 Fig.: II11/2

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## COMPONENT TESTING AND REPAIR

### Checking commutator end shield

Check deep-groove ball bearing on commutator end of armature for damage and smooth running.

Replace if appropriate.

Removing: Clamp armature in clamping support.

Use claw-type puller to remove deep-groove ball bearing (1) from armature shaft.

Clamping support:

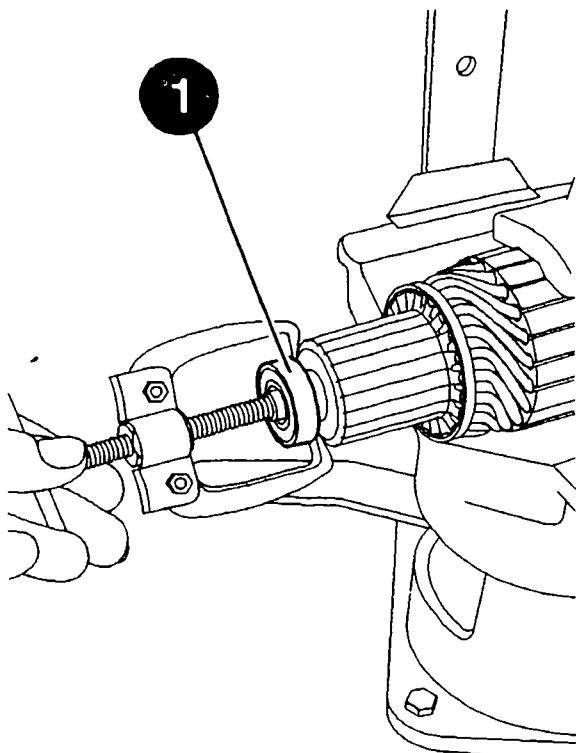
0 986 619 362

Claw-type puller:

comm. avail.

Continue: II13/1 Fig.: II12/2

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## COMPONENT TESTING AND REPAIR

### Checking commutator end shield

Installing: Slip intermediate bearing (1) onto armature shaft to support armature on mandrel press.

Press new deep-groove ball bearing (2) onto armature shaft. To do so, use pressing-in mandrel for needle bushing of intermediate bearing (3).

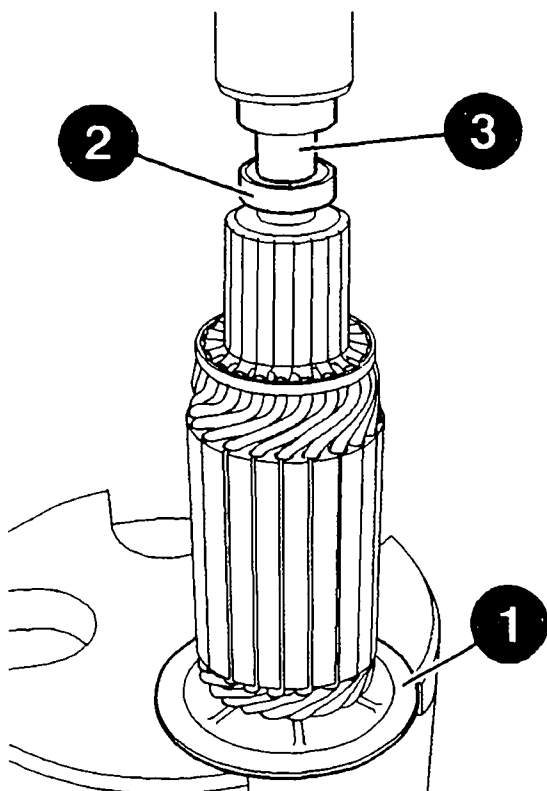
Mandrel press: comm. avail.

Pressing-in mandrel for  
needle bushing in

intermediate bearing: 0 986 617 130

Continue: II14/1 Fig.: II13/2

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## COMPONENT TESTING AND REPAIR

### Checking intermediate bearing

Check thrust washer for damage and replace if necessary.  
Always replace needle bushing of intermediate bearing and radial-lip-type oil seal.

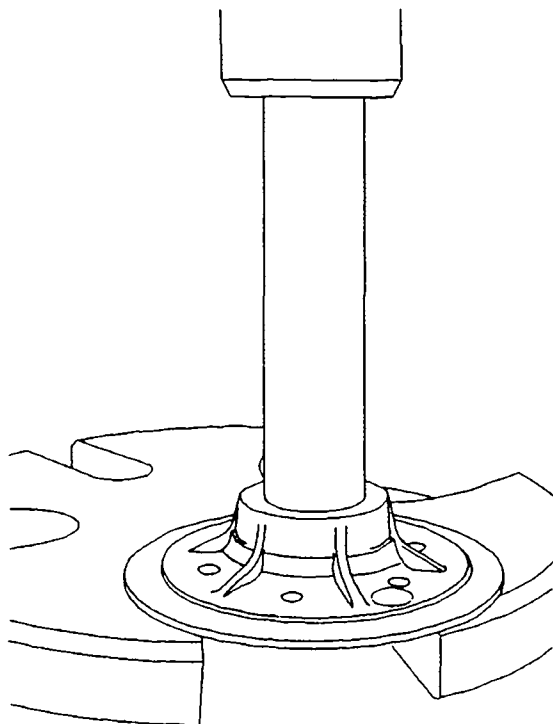
Removing: Press needle bushing and radial-lip-type oil seal out of intermediate bearing.

Mandrel press: comm. avail.

Pressing-out mandrel  
for needle bushing in  
intermediate bearing: 0 986 617 129

Continue: II15/1 Fig.: II14/2

KMS00179



# COMPONENT TESTING AND REPAIR

## Checking intermediate bearing

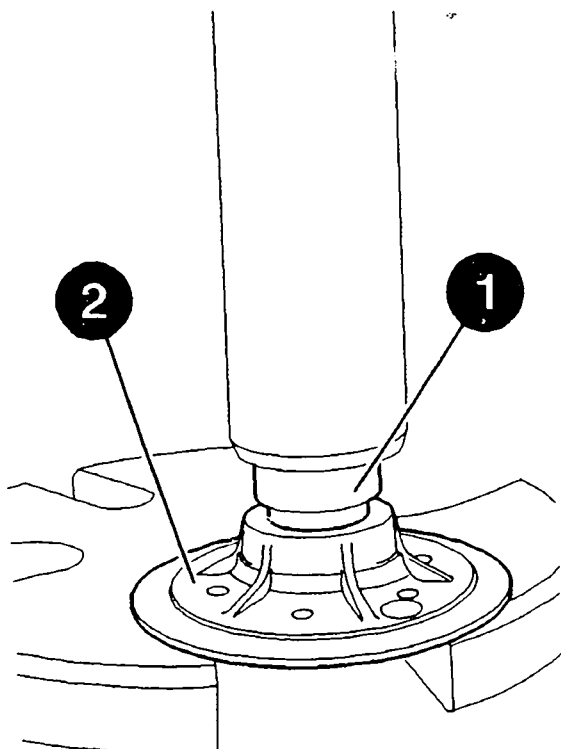
### Installing needle bushing:

Grease new needle bushing before pressing it in. Attach needle bushing to pressing-in mandrel (1) and press home in intermediate bearing (2) as far as pressing-in mandrel will go.

Mandrel press:	comm. avail.
Pressing-in mandrel for needle bushing in intermediate bearing:	0 986 617 130
Grease VS 10832 Ft:	5 932 240 000

Continue: II16/1 Fig.: II15/2

KMS00180



# COMPONENT TESTING AND REPAIR

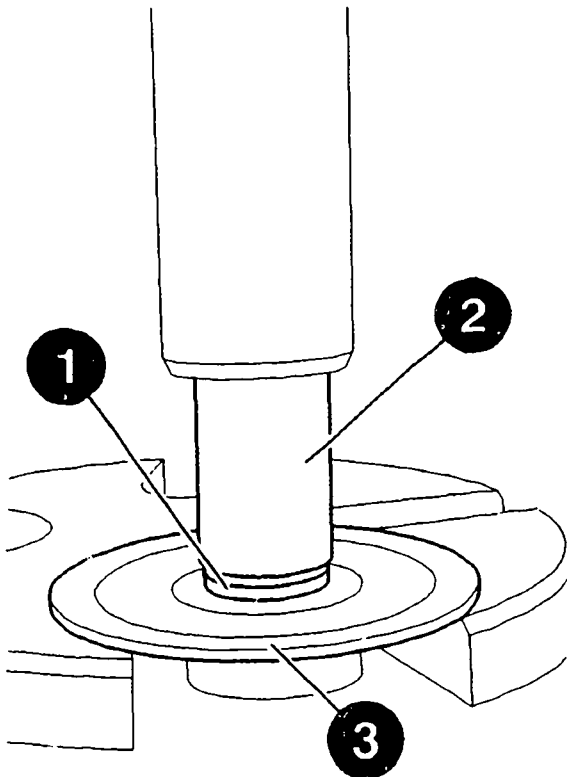
## Checking intermediate bearing

Installing radial-lip-type oil seal:  
Grease new seal (1) lightly before  
pressing it in and slip onto pressing-  
in mandrel (2) with open end facing  
upwards towards mandrel.

Pressing-in mandrel for  
radial-lip-type oil seal  
in intermediate bearing: 0 986 617 144  
Grease VS 10832 Ft: 5 932 240 000

Continue: II17/1 Fig.: II16/2

KMS00181



# COMPONENT TESTING AND REPAIR

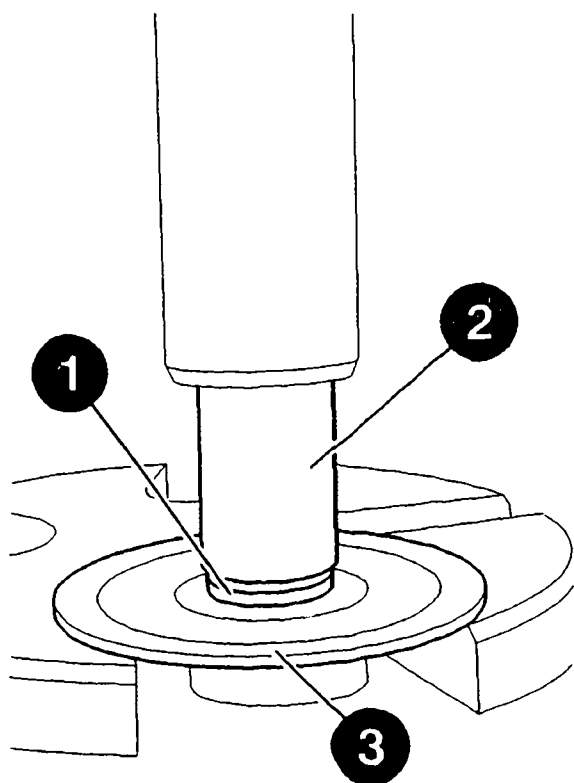
## Checking intermediate bearing

Installing radial-lip-type oil seal:  
Press home oil seal (1) in intermediate bearing (3) as far as pressing-in mandrel (2) will go.  
Make sure pressing-in mandrel is properly centered in needle bushing.

Mandrel press:	comm. avail.
Pressing-in mandrel for radial-lip-type oil seal in intermediate bearing:	0 986 617 144
Grease VS 10832 Ft:	5 932 240 000

Continue: II18/1 Fig.: II17/2

KMS00181



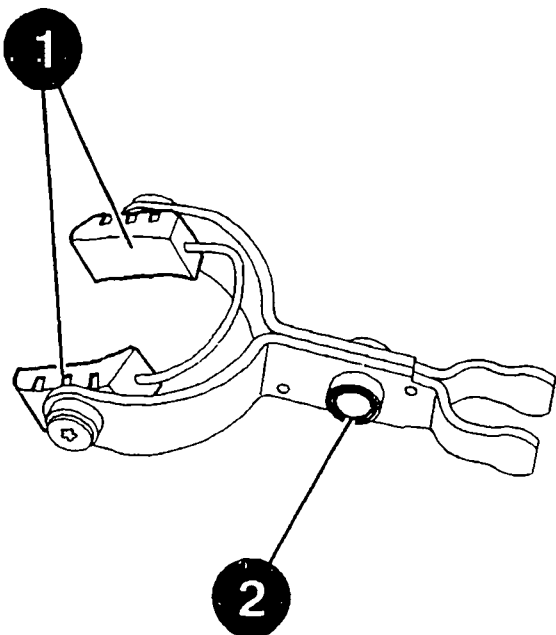
# COMPONENT TESTING AND REPAIR

## Checking engaging lever

Engaging lever must be replaced if sliders (1) or bushing (2) of engaging lever are/is worn.

Continue: II19/1 Fig.: II18/2

KMS00182



COMPONENT TESTING AND REPAIR

Checking gear unit

Check brake disk for damage and  
replace if necessary.

Continue: II20/1

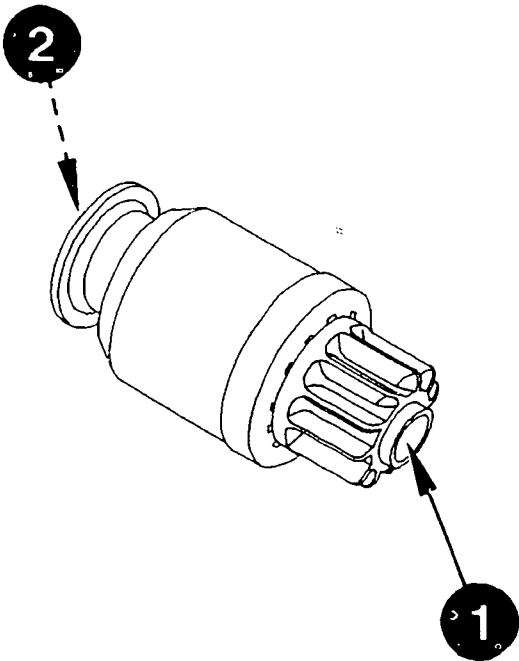
## COMPONENT TESTING AND REPAIR

### Checking gear unit

Entire overrunning-clutch drive must be replaced if mount (1) or spline shaft profile (2) exhibits running marks or shows signs of damage.

Continue: II21/1 Fig.: II20/2

KMS00184





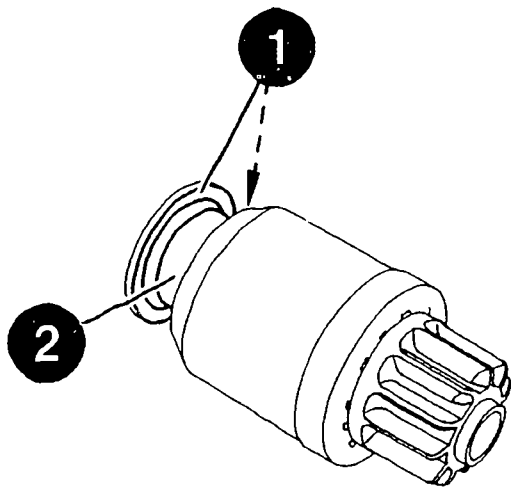
## COMPONENT TESTING AND REPAIR

### Checking gear unit

Check driver of engaging lever.  
Entire gear unit must be replaced  
if sliders of engaging lever have  
worn down edges (1) of driver (2).

Continue: II22/1 Fig.: II21/2

KMS00185



## COMPONENT TESTING AND REPAIR

### Checking gear unit

Check overrunning clutch.

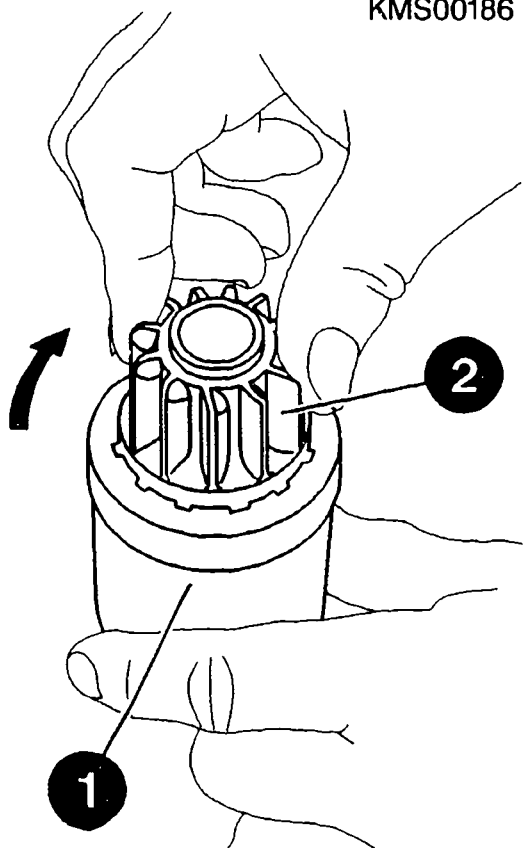
Hold housing (1) of overrunning clutch and turn pinion (2) in direction of operation (arrow).

Functioning of overrunning clutch must be indicated by audible engaging of the clutch tootingh.

Hold housing and turn pinion in opposite direction - positive locking must be found.

Continue: II23/1 Fig.: II22/2

KMS00186



## COMPONENT TESTING AND REPAIR

### Checking gear unit

Check meshing spring.

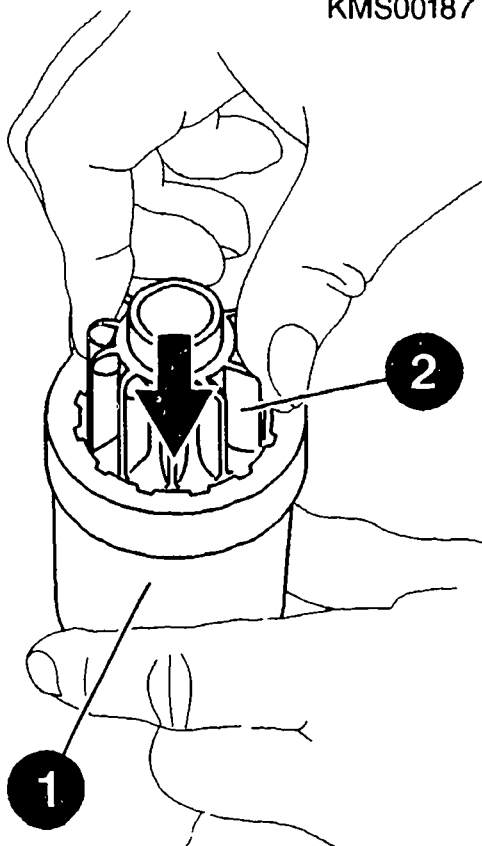
Hold housing (1) of overrunning clutch and press pinion (2) into housing as far as it will go.

Pinion displacement: 10...11,4 mm

Pinion must return to its initial position on being released.

Continue: II24/1 Fig.: II23/2

KMS00187



## COMPONENT TESTING AND REPAIR

### Checking carbon brushes

Check tightness of connections.  
Replace carbon brushes if contact surfaces are scored or chipped or if minimum size has been reached.

As-new brush size:	17,5 mm
Min. brush size:	9,5 mm

Continue: II25/1

# COMPONENT TESTING AND REPAIR

## Checking brush holder plate

Replace damaged, rusty or scorched springs.

Check for short to ground in brush holders (1), which are insulated with respect to brush holder plate (2).

Interturn-short-circuit tester:

0 986 619 110

Test prods:

0 986 619 101

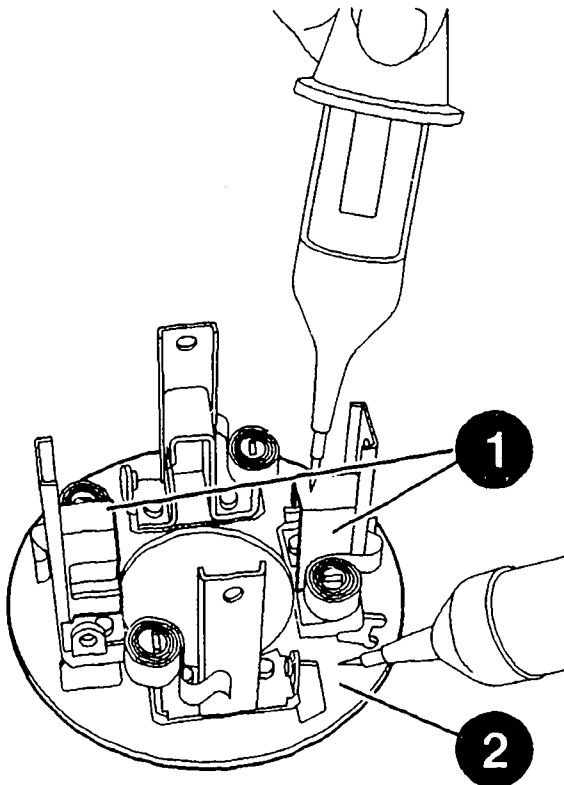
Ground-short test voltage

12 V starting motor: 40 V

24 V starting motor: 80 V

Continue: II26/1 Fig.: II25/2

KMS00188



## COMPONENT TESTING AND REPAIR

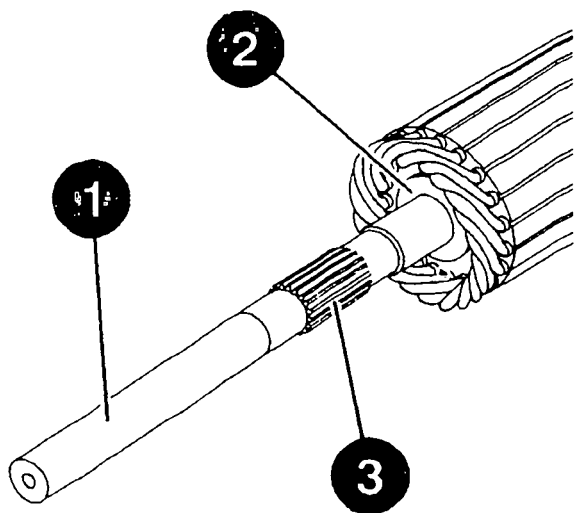
### Checking armature

Examine contact surface of overrunning-clutch drive (1) and intermediate bearing (2), as well as spline shaft profile (3) for running marks and damage.

Replace armature if necessary.

Continue: II27/1 Fig.: II26/2

KMS00189



## COMPONENT TESTING AND REPAIR

### Checking armature

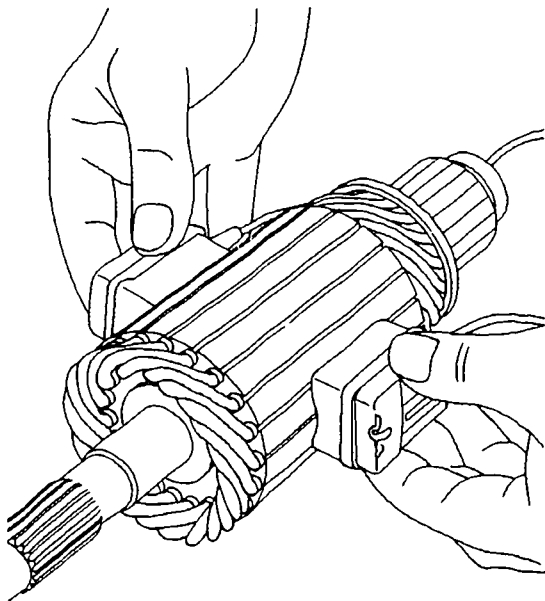
Check armature for interturn short circuit.

This involves using the appropriate tester and test prods.

Interturn-short-circuit tester  
with test prods: 0 986 619 110

Continue: II28/1 Fig.: II27/2

KMS00190



# COMPONENT TESTING AND REPAIR

## Checking armature

Use tester and test prods to check armature for ground short and continuity (black laminations are an indication of open circuit)

### Interturn-short-circuit

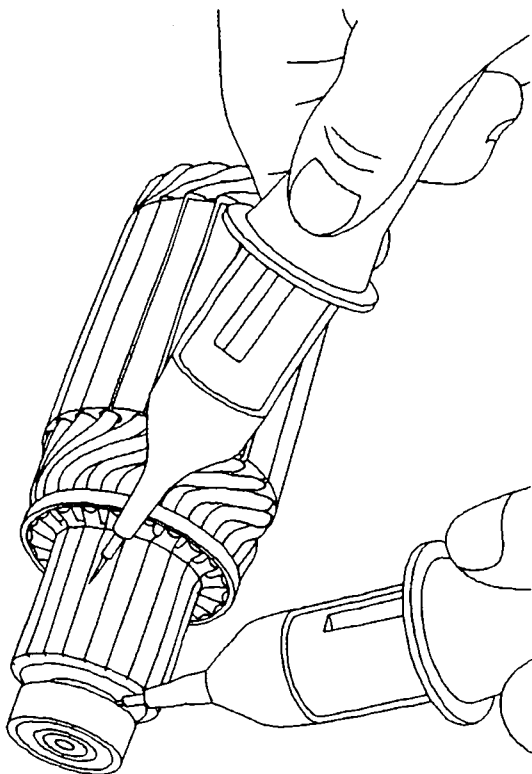
tester:	0	986	619	110
Test prods:	0	986	619	101

### Ground short test voltage

12 V starting motor:	40 V
24 V starting motor:	80 V
Continuity test voltage:	40 V

Continue: IIII01/1 Fig.: II28/2

KMS00191





# COMPONENT TESTING AND REPAIR

## Checking commutator

Check commutator for true running.  
If radial runout is not within  
tolerance, the commutator must be  
turned down.

Magnetic instrument

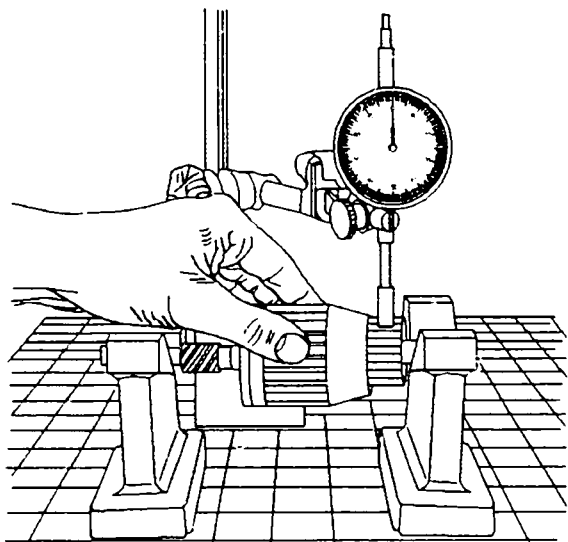
stand:	4 851 601 124
Dial indicator:	1 687 233 011

Radial runout

- Commutator:	0,03 mm
- Laminated core:	0,06 mm

Continue: III02/1 Fig.: III01/2

KMS00192



# COMPONENT TESTING AND REPAIR

## Checking commutator

Turning down involves mounting the armature in a three-jaw chuck and tailstock chuck (1).

Chip thickness must not exceed 0.03 mm.

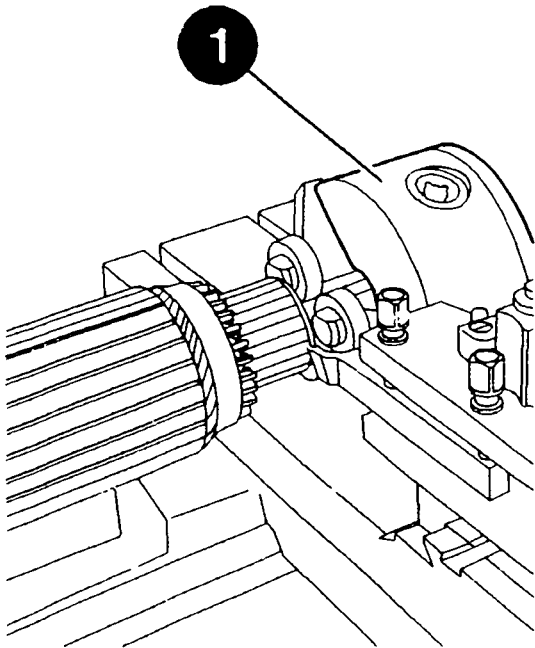
Pay attention to minimum diameter.

Tailstock chuck  
with Morse taper 2: 0 986 619 156

Minimum diameter: 42,5 mm

Continue: III03/1 Fig.: III02/2

KMS00193



## COMPONENT TESTING AND REPAIR

### Checking commutator

After being turned down, the insulation of the commutator laminations must be sawn out with a suitable tool to a depth of 0.8 mm.

Continue: III03/2

## COMPONENT TESTING AND REPAIR

After sawing, turn down commutator again and check for interturn short circuit and ground short. Pay attention to diameter.

Interturn-short-circuit  
tester:

0 986 619 110

Minimum diameter: 42,5 mm

Ground short test voltage

12 V starting motor: 40 V

24 V starting motor: 80 V

Continue: III04/1

# COMPONENT TESTING AND REPAIR

## Checking excitation winding

User tester and test prods to check winding for ground short.

Interturn-short-circuit  
tester:

0 986 619 110

Test prods:

0 986 619 101

Ground short test voltage

12 V starting motor:

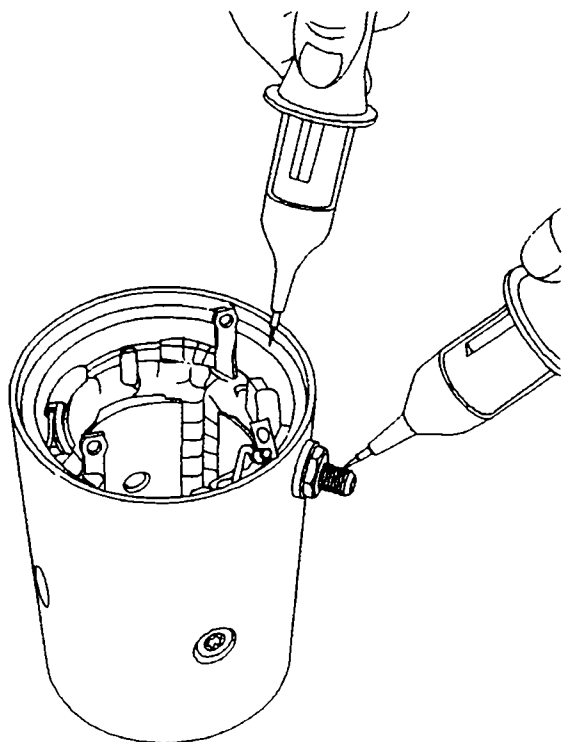
40 V

24 V starting motor:

80 V

Continue: III05/1 Fig.: III04/2

KMS00194



# COMPONENT TESTING AND REPAIR

## Checking excitation winding

Use tester and test prods to check winding for continuity.

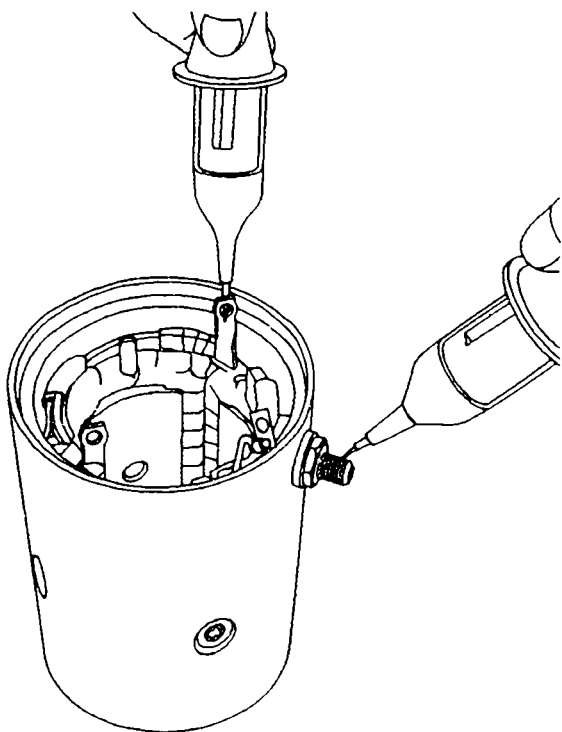
### Interturn-short-circuit

tester:	0 986 619 110
Test prods:	0 986 619 101

Continuity test voltage: 40 V

Continue: III06/1 Fig.: III05/2

KMS00195



# COMPONENT TESTING AND REPAIR

## Checking excitation winding

Use tester to check shunt field resistance.

Alternator tester: 0 684 201 200  
(optionally Motortester)

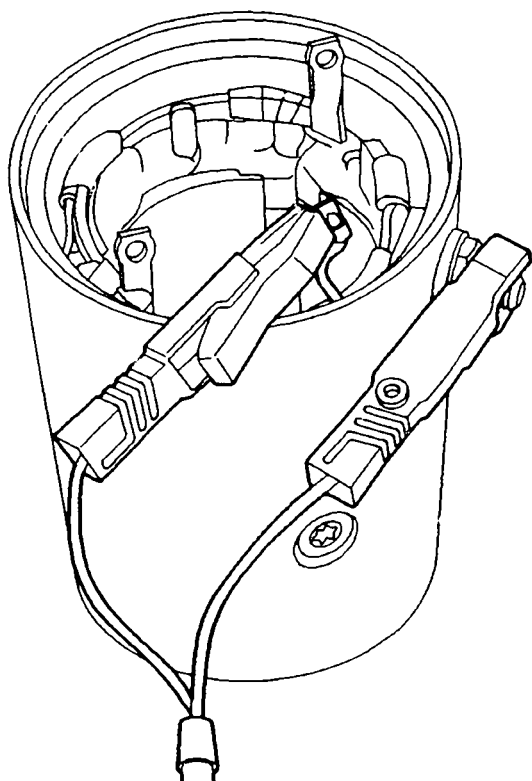
### Shunt field resistance

12 V starting motor: 0,38...0,42 Ohm

24 V starting motor: 1,60...1,76 Ohm

Continue: III07/1 Fig.: III06/2

KMS00196



## COMPONENT TESTING AND REPAIR

### Replacing excitation winding

Replace damaged, defective, scorched or unsoldered windings.

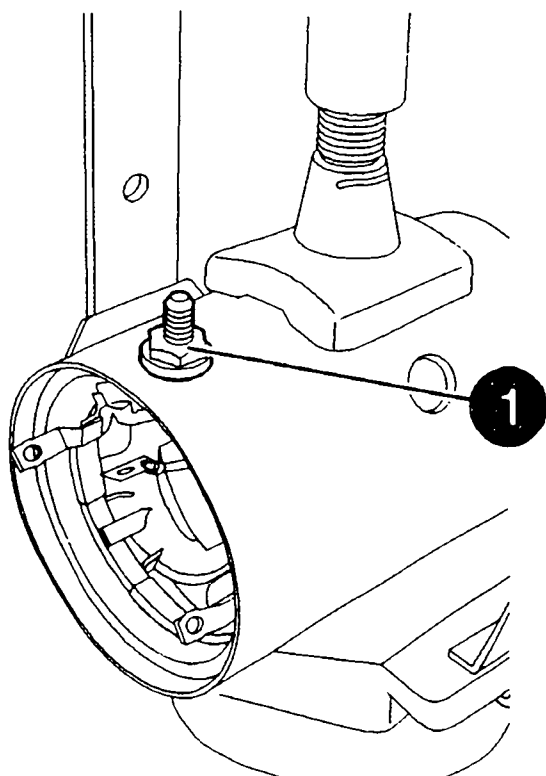
Removing: Insert stator frame in clamping support and mark position of pole shoes. Remove securing nut for terminal screw of excitation winding (1).

Clamping support:

0 986 619 362

Continue: III08/1 Fig.: III07/2

KMS00197



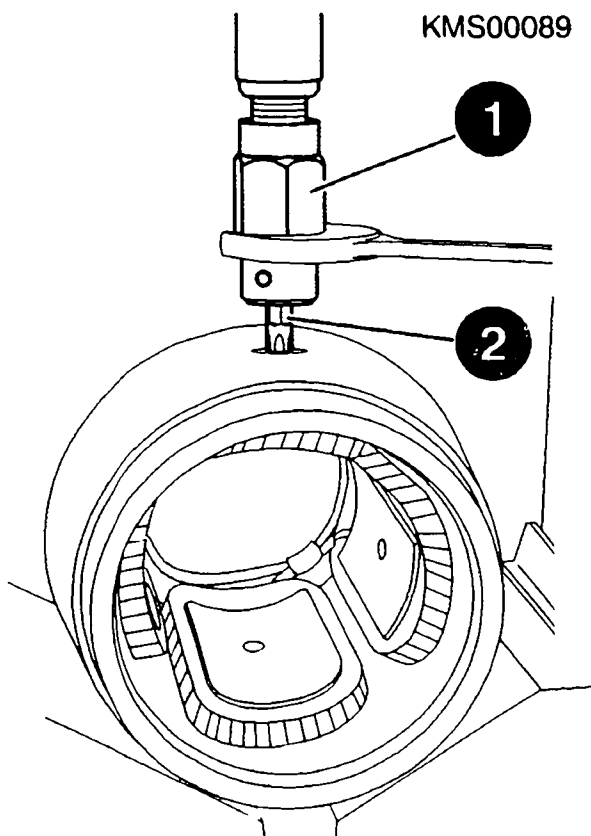
# COMPONENT TESTING AND REPAIR

## Replacing excitation winding

Use pole-shoe screwdriver (1) and Torx socket (2) to unfasten pole-shoe screws and remove pole shoes and winding towards drive end bearing side.

Pole-shoe screwdriver: 0 986 619 393  
Torx T50 bit socket  
with hexagon 5/16": comm. avail.

Continue: III09/1 Fig.: III08/2





# COMPONENT TESTING AND REPAIR

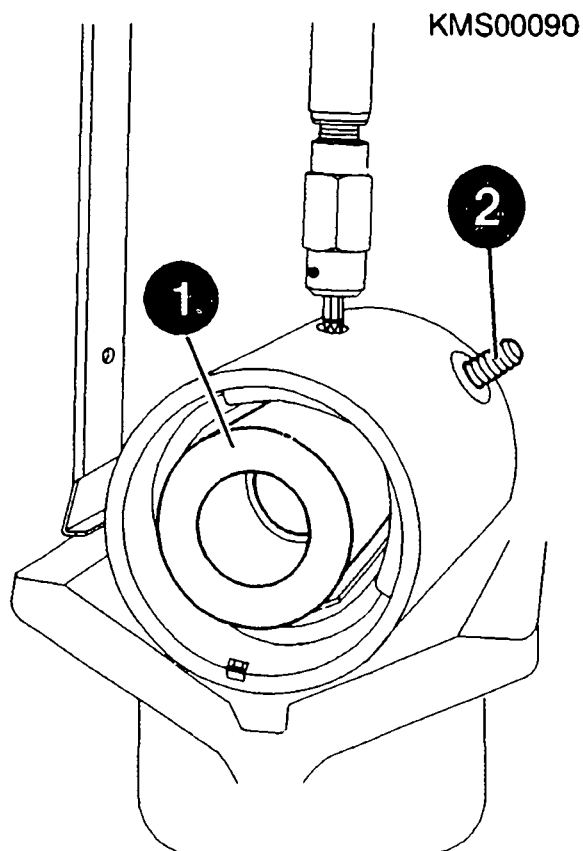
## Replacing excitation winding

Installing: Warm excitation winding before fitting, insert with pole shoes in stator frame from drive end bearing side and slightly tighten pole-shoe screws. Pay attention to marks.

Press in driving-in mandrel (1).

Mandrel press:	comm. avail.
Driving-in mandrel diameter:	75,85 - 0,05 mm (user-manufacture)

Continue: III10/1 Fig.: III09/2



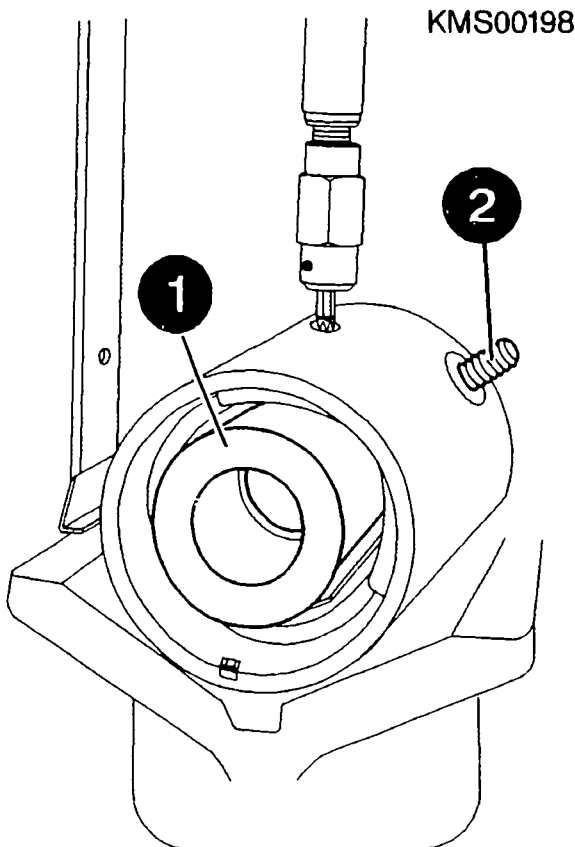
## COMPONENT TESTING AND REPAIR

### Replacing excitation winding

Tighten pole-shoe screws and press out driving-in mandrel (1). Fit connection of excitation winding (2).  
Use torque wrench.

Mandrel press:	comm. avail.
Pole-shoe screwdriver:	0 986 619 393
Torx T50 bit socket with hexagon 5/16":	comm. avail.
Torque wrench:	comm. avail.
Tightening torques	
Pole-shoe screws:	40...53 Nm
Terminal screw:	15...17 Nm

Continue: III11/1 Fig.: III10/2



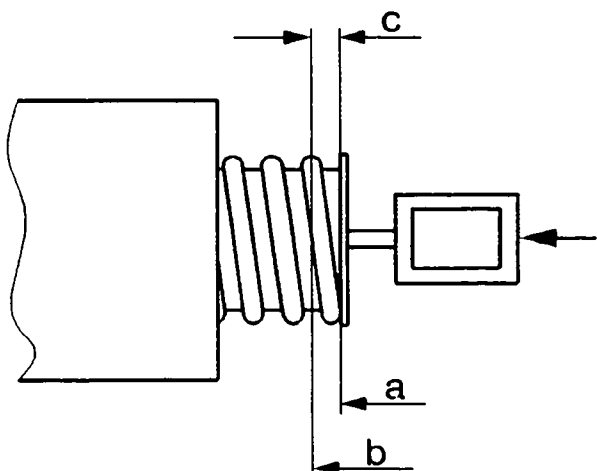
## COMPONENT TESTING AND REPAIR

### Checking solenoid switch

Examine solenoid switch for damage.  
Check burn-off reserve.  
Press in armature by hand until jumper makes contact (a) with terminal stud.  
As the armature is pressed further in as far as the stop (b), a noticeable increase in resistance can be felt.  
The difference between positions (a) and (b) is the burn-off reserve (c).  
Solenoid switch is to be replaced if there is no longer any burn-off reserve.

Continue: III12/1 Fig.: III11/2

KMS00238



# COMPONENT TESTING AND REPAIR

## Checking solenoid switch

Use tester to check resistance of pull-in winding (term. 50/term. 30-f).

Alternator tester: 0 684 201 200

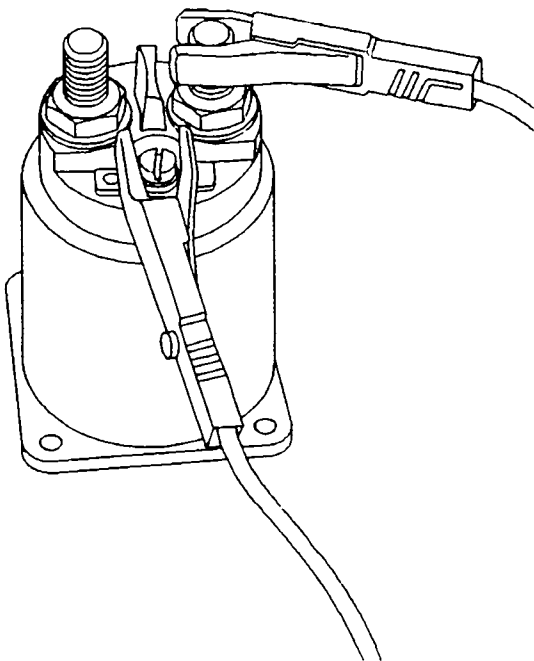
### Resistance

12 V - solenoid switch:  
0,175...0,185 Ohm

24 V - solenoid switch:  
0,524...0,552 Ohm

Continue: III13/1 Fig.: III12/2

KMS00239



# COMPONENT TESTING AND REPAIR

## Checking solenoid switch

Use tester to check resistance of holding winding (term. 50/ground).

Alternator tester: 0 684 201 200

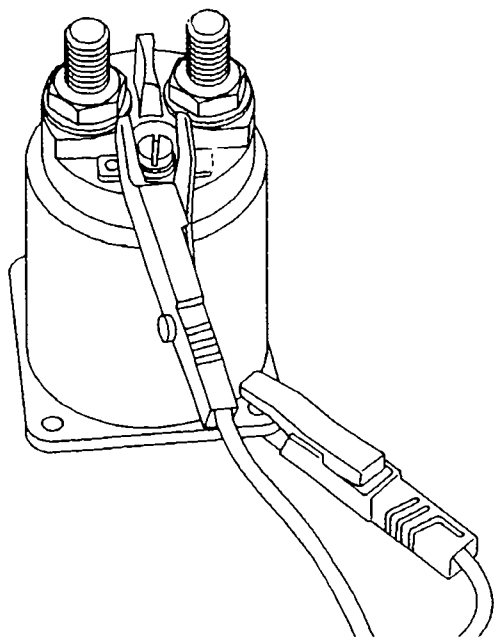
### Resistance

12 V - solenoid switch:  
0,421...0,443 Ohm

24 V - solenoid switch:  
1,6...1,7 Ohm

Continue: III14/1 Fig.: III13/2

KMS00240



## COMPONENT TESTING AND REPAIR

### Checking solenoid switch

Neither the tests described nor proper functioning of the solenoid switch when testing the function of the starting motor following repair can provide reliable information on trouble-free operation of the solenoid switch over a lengthy period. It is therefore advisable to renew the solenoid switch when repairing the starting motor.

Continue: I01/1

# STARTING-MOTOR ASSEMBLY TABLE

Intermediate bearing assembly	III16/1
Gear unit assembly	III18/1
Drive end bearing assembly	III19/1
Carbon brush assembly	III21/1
Brush holder plate assembly	III22/1
Checking brush pressure	III24/1
Commutator end shield assembly	III25/1
Checking and adjusting armature axial clearance	III27/1
Bearing end plate assembly	IV01/1
Checking armature braking torque	IV02/1
Checking pinion rest position	IV04/1
Solenoid switch assembly	IV05/1

Continue: I01/1

## STARTING MOTOR ASSEMBLY

Intermediate bearing assembly

Lubricate as per lubrication schedule before and during assembly.

Clamp stator frame in clamping support. Insert armature in stator frame from drive end.

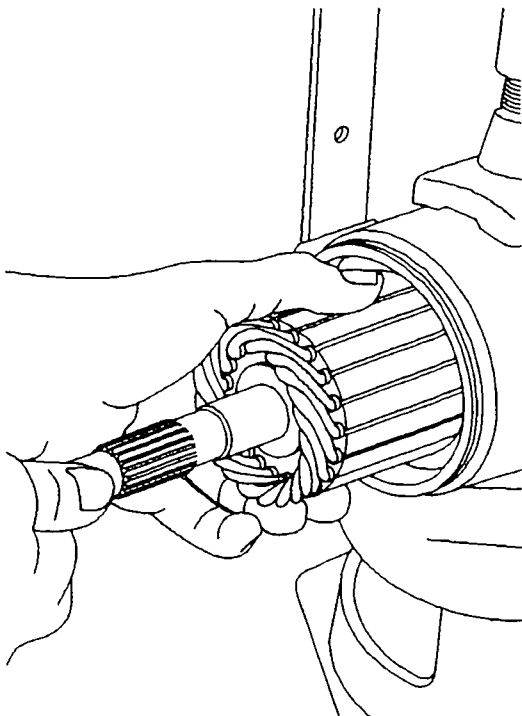
### ATTENTION:

Take care not to damage excitation winding.

Clamping support: 0 986 619 362

Continue: III17/1 Fig.: III16/2

KMS00174





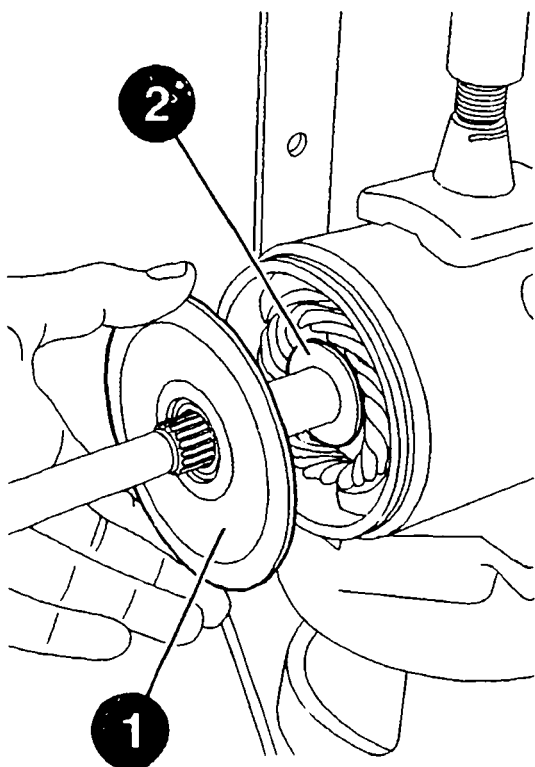
## STARTING MOTOR ASSEMBLY

### Intermediate bearing assembly

Slip thrust washer (2) and intermediate bearing (1) with collar facing armature winding onto armature shaft.

Continue: III18/1 Fig.: III17/2

KMS00173



## STARTING MOTOR ASSEMBLY

### Gear unit assembly

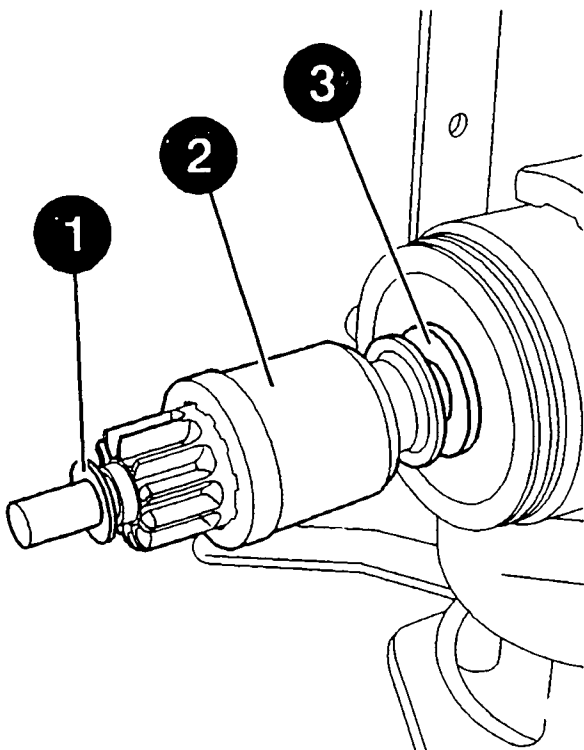
Slip brake disk (3), overrunning-clutch drive with pinion (2) and stop disk (1) onto armature shaft.

#### ATTENTION:

Spline shaft profile of gear unit must be dry and free from grease to stop pasting up of armature shaft. Only grease spline shaft profile of armature shaft.

Continue: III19/1 Fig.: III18/2

KMS00172



## STARTING MOTOR ASSEMBLY

### Drive end bearing assembly

Fit new O-ring (1) at drive end bearing seat of stator frame.

Slip on drive end bearing (2) together with engaging lever (3) and insert this in driver (4) at gear unit.

Ensure proper fit and pay attention to mark on drive end bearing.

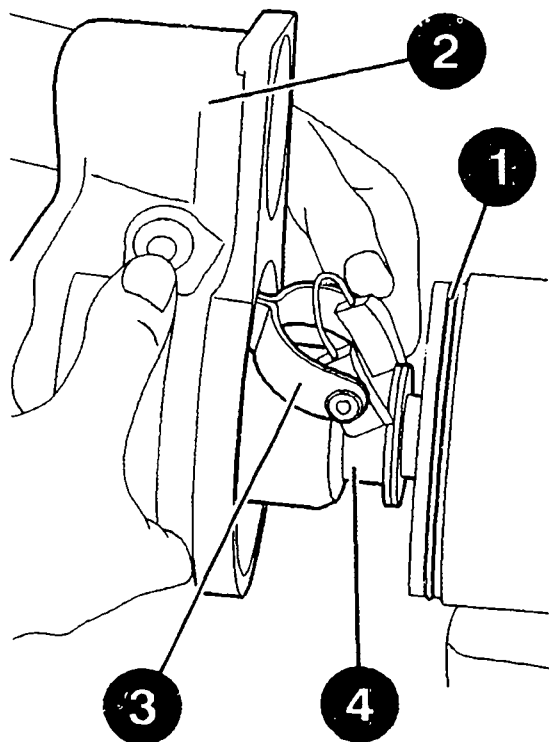
Make sure armature shaft is properly seated in drive end bearing.

### ATTENTION: DANGER OF INJURY

Drive end bearing is not fixed at stator frame.

Continue: III20/1 Fig.: III19/2

KMS00199



# STARTING MOTOR ASSEMBLY

## Drive end bearing assembly

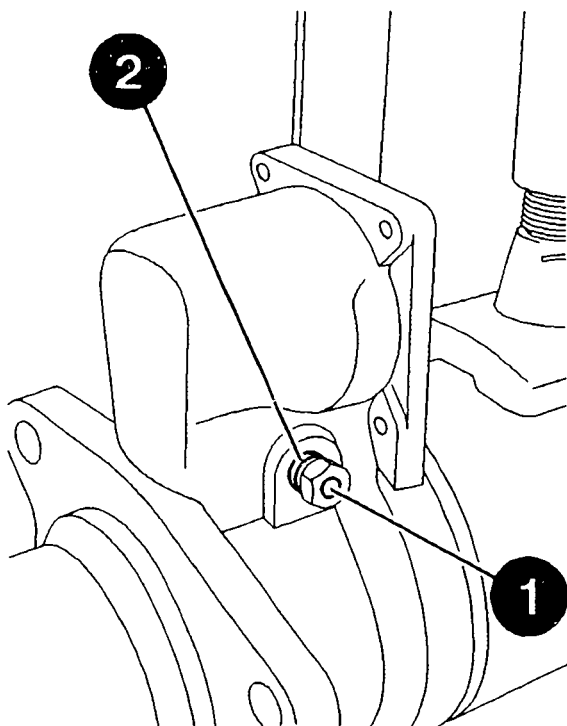
If appropriate, renew bearing pin (1) of engaging lever, fit with new copper seal (2) and secure with Loctite. Make sure engaging lever runs smoothly on bearing pin. Use torque wrench.

Torque wrench: comm. avail.

Tightening torque  
(hexagon nut): 9...11 Nm  
Loctite VS 14618 Kk: 5 965 930 512

Continue: III21/1 Fig.: III20/2

KMS00170



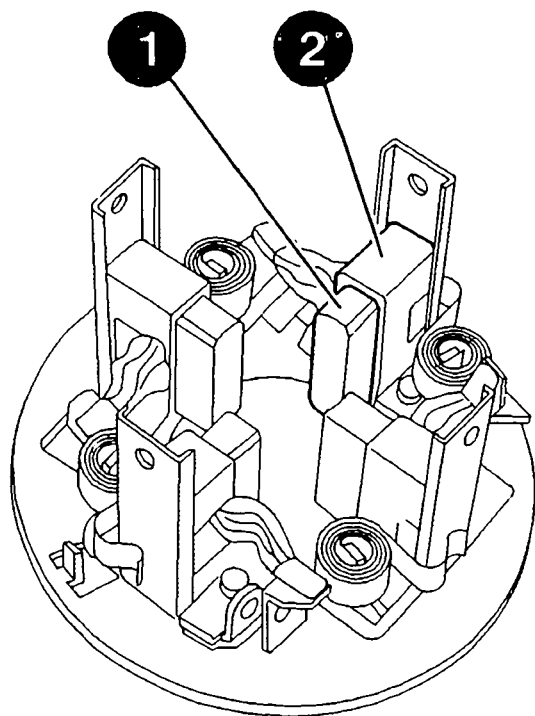
# STARTING MOTOR ASSEMBLY

## Carbon brush assembly

Insert new carbon brushes (1) in  
brush holder (2).

Continue: III22/1 Fig.: III21/2

KMS00169



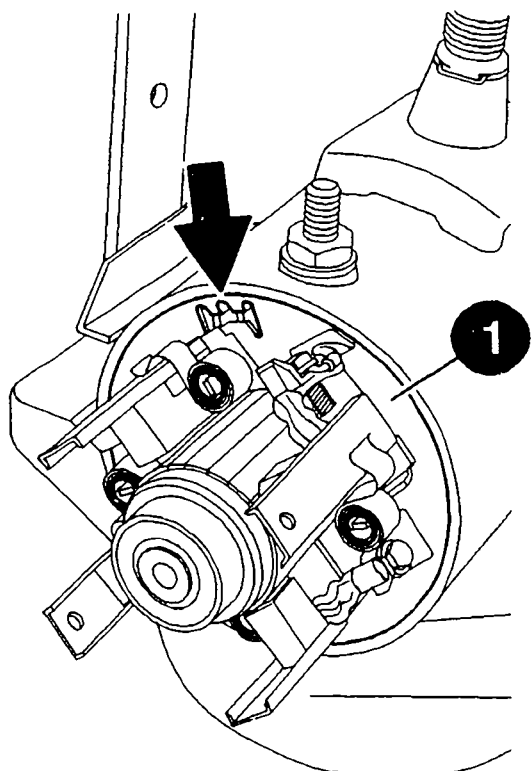
## STARTING MOTOR ASSEMBLY

### Brush holder plate assembly

Slip brush holder plate (1) with carbon brushes over commutator and insert in stator frame. Lug on stator frame must engage in locking mechanism of brush holder plate (see arrow). Ensure proper positioning.

Continue: III23/1 Fig.: III22/2

KMS00201



## STARTING MOTOR ASSEMBLY

### Brush holder plate assembly

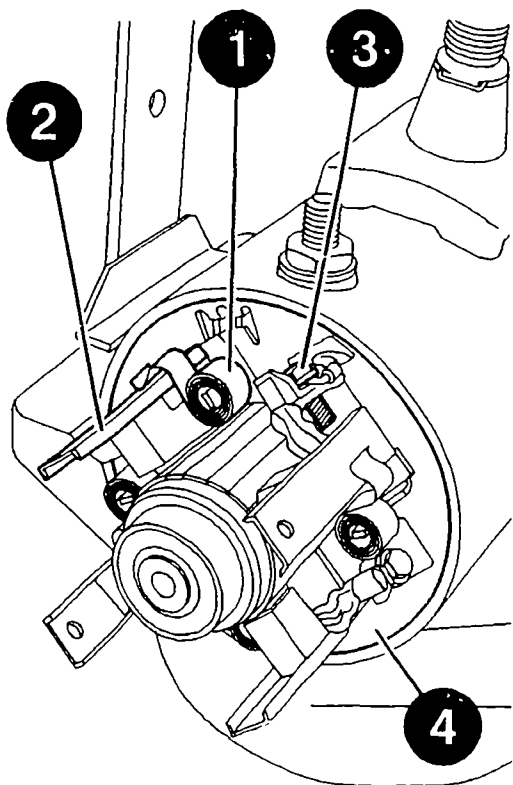
Attach connections (3) of carbon brushes and excitation winding to brush holder plate (4). Use torque wrench. Lift spiral springs (1) with appropriate tool and pull out assembly tool (2). Press stranded wires of carbon brushes outwards; make sure there is no possibility of contact with commutator.

Torque wrench: comm. avail.

Tightening torque: 3...4 Nm

Continue: III24/1 Fig.: III23/2

KMS00168



# STARTING MOTOR ASSEMBLY

## Checking brush pressure

Use spring balance to check brush pressure.

Spring balance  
(0...160 N):

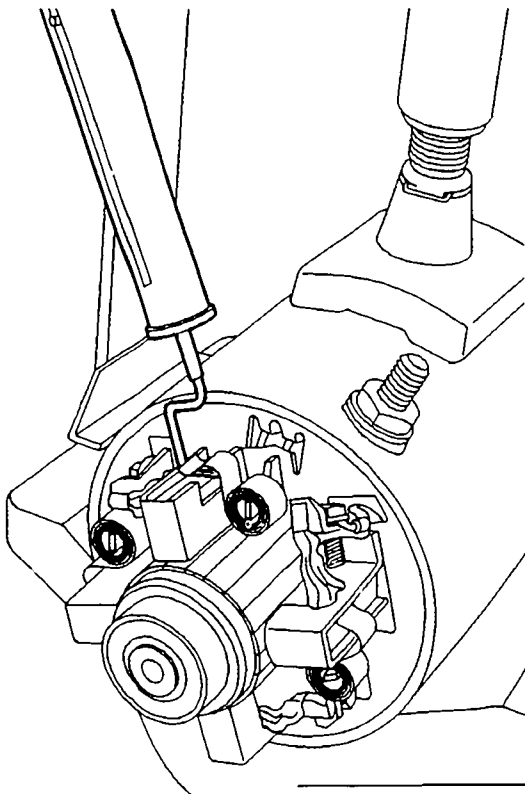
comm. avail.

Brush pressure of  
new carbon brushes:

47...53 N

Continue: III25/1 Fig.: III24/2

KMS00202





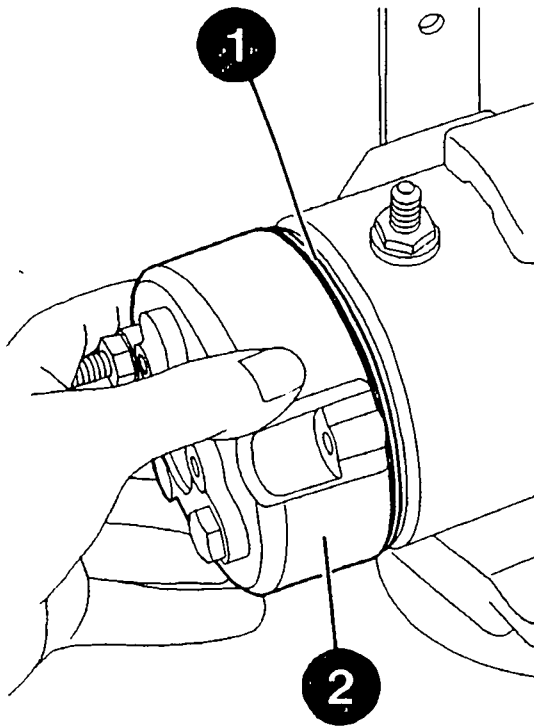
# STARTING MOTOR ASSEMBLY

## Commutator end shield assembly

Fit new O-ring (1) at commutator end shield (2) and insert commutator end shield in stator frame.  
Pay attention to mark.

Continue: III26/1 Fig.: III25/2

KMS00183



# STARTING MOTOR ASSEMBLY

## Commutator end shield assembly

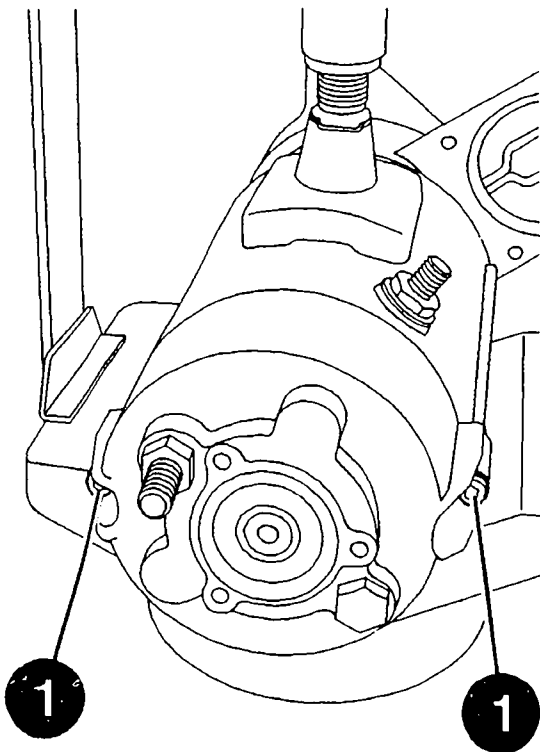
Re-check proper positioning of drive end bearing and commutator end shield (marks) and secure with bolts (1). Bolts must run parallel with theoretical center axis of starting motor. Use torque wrench.

Torque wrench: comm. avail.

Tightening torque: 9,8...12,2 Nm

Continue: III27/1 Fig.: III26/2

KMS00203



## STARTING MOTOR ASSEMBLY

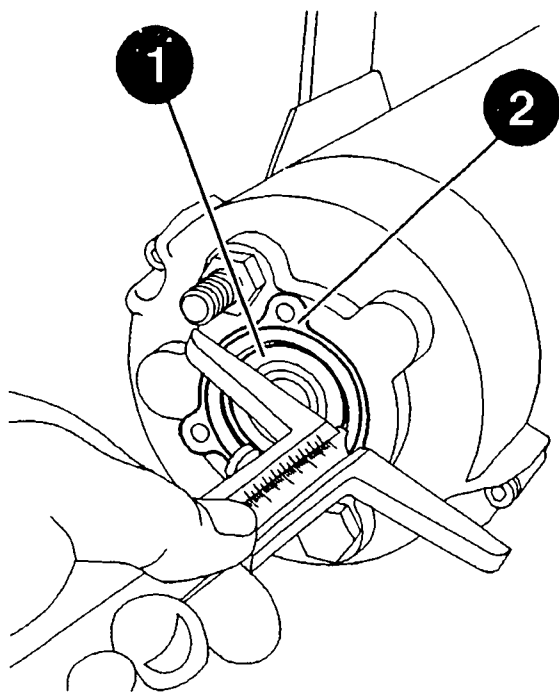
### Checking and adjusting armature axial clearance

Determine indentation dimension  $x$ . To do so, press armature with deep-groove ball bearing by hand against drive end bearing. Use depth gauge to establish indentation dimension  $x$  between outer race of deep-groove ball bearing (1) and end face of commutator end shield (2).

Depth gauge: comm. avail.

Continue: III28/1 Fig.: III27/2

KMS00204



## STARTING MOTOR ASSEMBLY

### Checking and adjusting armature axial clearance

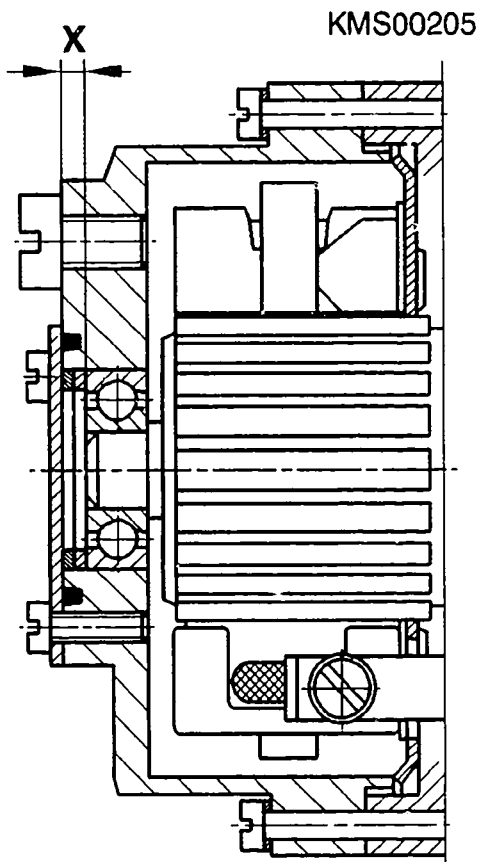
Provide compensation for indentation dimension  $x$ .

By fitting shims, dimension  $x$  must be reduced to the extent required to maintain a clearance of 0,1...0,3 mm between outer race of deep-groove ball bearing and end face of commutator end shield.

Three different shims are available for this purpose with thicknesses of 1.0 mm, 1.2 mm and 1.5 mm.

Armature axial clearance:            0,1...0,3 mm

Continue: IV01/1 Fig.: III28/2



## STARTING MOTOR ASSEMBLY

### Bearing end plate assembly

Insert new O-ring in annular groove of commutator end shield and secure bearing end plate (2) with the three bolts (1).

Use torque wrench.

Make sure O-ring and shims are properly positioned.

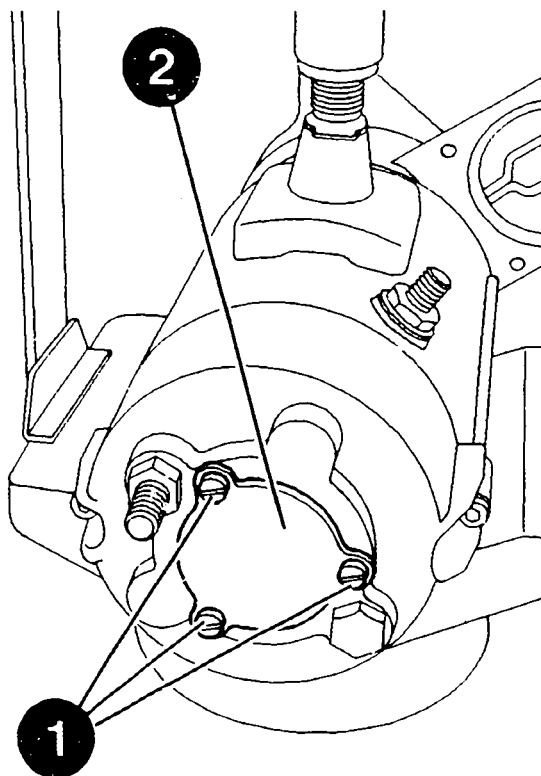
Check freedom of movement of armature.

Torque wrench: comm. avail.

Tightening torque: 4...5 Nm

Continue: IV02/1 Fig.: IV01/2

KMS00166



## STARTING MOTOR ASSEMBLY

### Checking armature braking torque

Apply torquemeter at pinion such that it is loaded in direction of operation (see arrow).

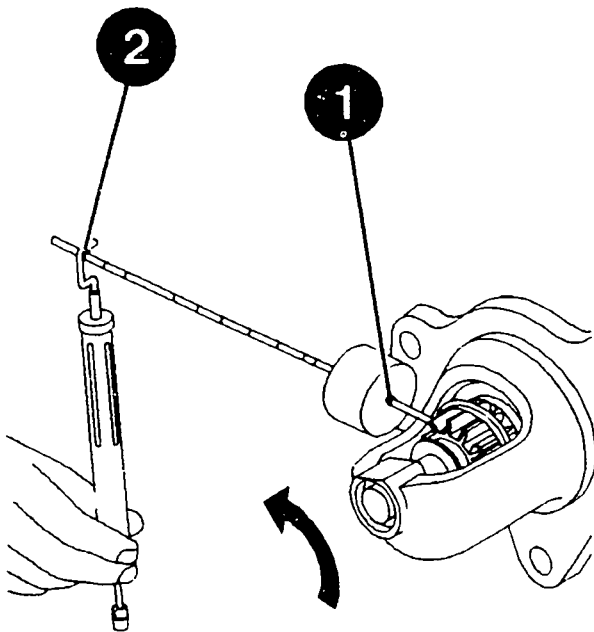
Move torquemeter to horizontal position.

Shift weight to second mark "2.0" (1). Suspend spring balance at last mark "8" (2).

Torquemeter:	0 986 617 206
Spring balance:	0 986 619 181

Continue: IV03/1 Fig.: IV02/2

KMS00242



## STARTING MOTOR ASSEMBLY

### Checking armature braking torque

Pull on spring balance until pinion and armature start to turn.

Take scale reading from spring balance. This must be between 0,21...0,35 kg, corresponding to a tensile force of 2,0...3,4 N.

The armature braking torque is then within the required range.

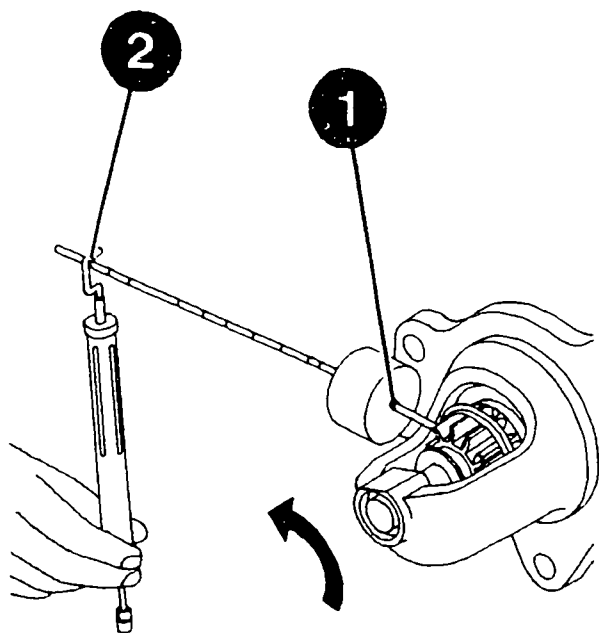
If this is not the case, check both the components and their assembly.

Armature braking

torque: 0,8...1,2 Nm

Continue: IV04/1 Fig.: IV03/2

KMS00242



# STARTING MOTOR ASSEMBLY

## Checking pinion rest position

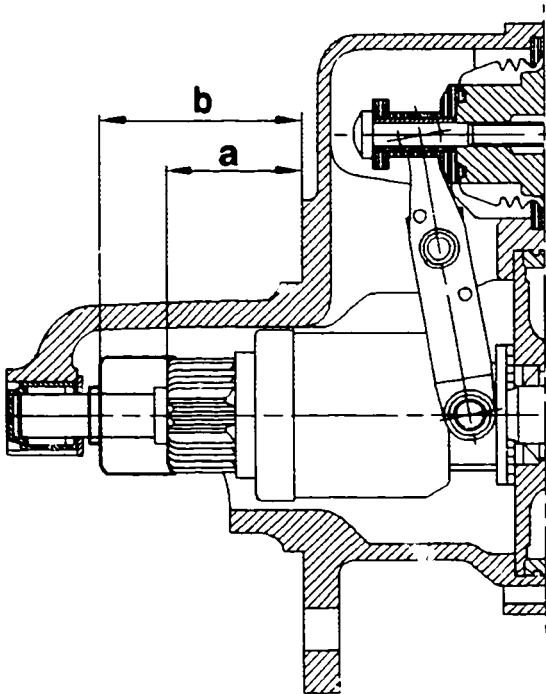
Dimension a for pinion rest position and total pinion travel b must be within stated range.

If not, check both the components and their assembly.

Pinion rest position a: 47 ...49 mm  
Total pinion travel b: 68,2...70,8 mm

Continue: IV05/1 Fig.: IV04/2

KMS00206



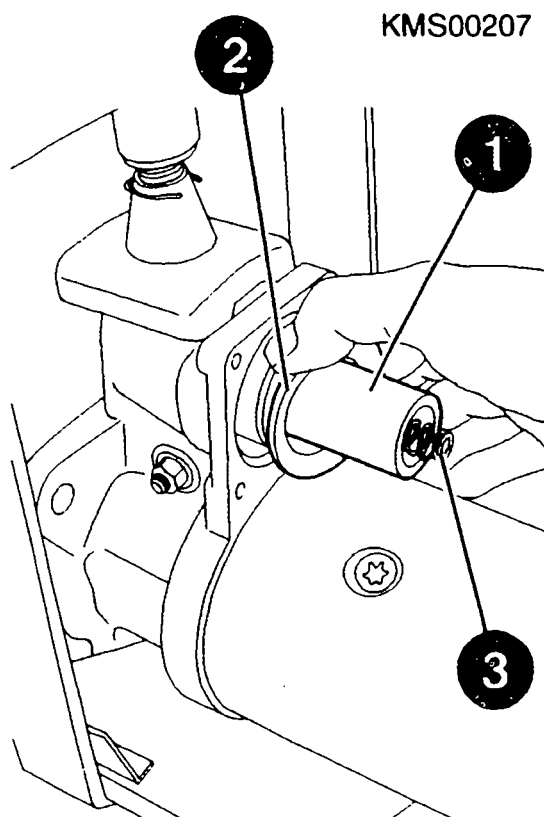


## STARTING MOTOR ASSEMBLY

### Solenoid switch assembly

Re-clamp starting motor.  
Press pinion against stop disk,  
grasp switch armature (1) at rubber  
bellows (2) and place in position  
at engaging lever.  
Pay attention to reset spring (3).

Continue: IV06/1 Fig.: IV05/2



# STARTING MOTOR ASSEMBLY

## Solenoid switch assembly

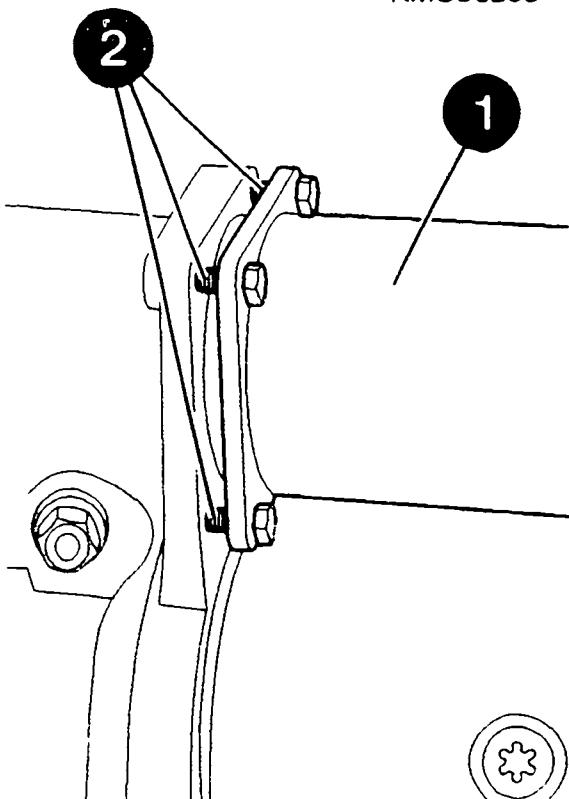
Slip solenoid switch (1) onto switch armature and screw on at drive end bearing. Pay attention to mark. Always use 4 new securing bolts (2) of strength class 10.9. Use torque wrench.

Torque wrench: comm. avail.

Tightening torque: 7,6...8,4 Nm

Continue: IV07/1 Fig.: IV06/2

KMS00208



# STARTING MOTOR ASSEMBLY

## Solenoid switch assembly

Attach busbar (1) to solenoid switch and terminal stud of excitation winding.

**ATTENTION:** First tighten the two securing nuts by hand.  
Use torque wrench.

Torque wrench: comm. avail.

Tightening torque

At terminal screw of excitation winding:

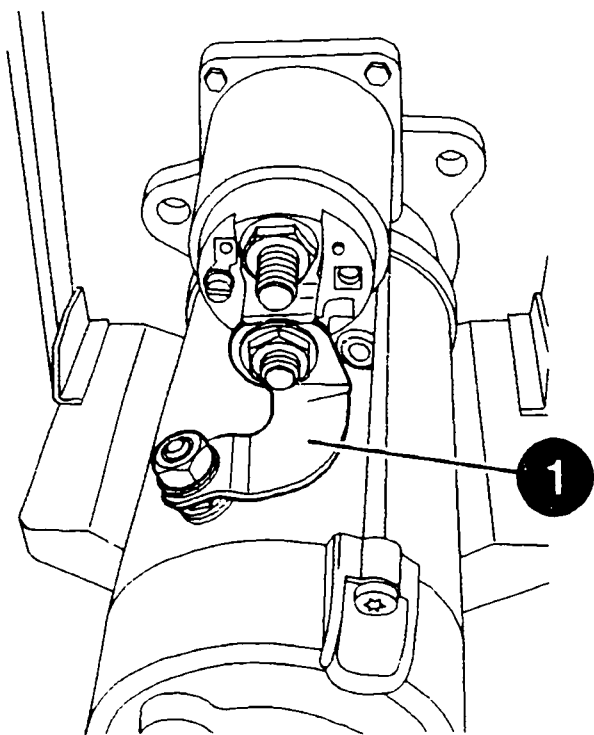
15...17 Nm

At solenoid switch:

16...20 Nm

Continue: I01/1 Fig.: IV07/2

KI:S00163



**EDITORIAL NOTE**

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Continue: IV08/2

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Continue: I01/1